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**A multidimensional framework to improve knowledge flow and
innovation process at the fuzzy front-end: a case study in a
Brazilian technology-based firm**

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Dissertation

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I dedicate this victory to my parents, Francisco and Maria Aparecida, wonderful people who taught me to value education, by the incentives throughout my training and the examples of dedication and work!

Dedico essa vitória aos meus pais, Francisco e Maria Aparecida, pessoas maravilhosas que me ensinaram a valorizar a educação, pelos incentivos ao longo da minha formação e pelos exemplos de dedicação e trabalho.

Abstract

Considering our competitive environment, with rapid technology changes, it is possible to observe a decrease in the product life cycle and a clear need for companies to develop innovative products with viable cost. In this context, companies are increasing their attention to the New Product Development (NPD) activities, recognized as a key driver of both top-and-bottom line performance in the technology sector.

The first part of NPD, called Fuzzy Front-End (FFE), is generally regarded in the literature as one of the greatest opportunities for improvements in the innovation process, considering that this phase is characterized by the product strategy formulation, opportunity identification, idea generation and planning in general. Effectiveness in this phase requires a large amount of knowledge and expertise from several actors, both internal and external to the company. Because of this, an efficiency in knowledge sharing management become strategic for organizing the information and knowledge available inside the company and support the relationship with external actors.

After understanding and analyzing how the “knowledge creation” unfolds within the FFE of NPD, the main goal of this work is to model this process into a multidimensional framework to enhance innovation process and knowledge management, through the perspective of absorptive capacity - emerging from the dynamic interactions between the individuals, the environment and the organization. The framework will be verified with insights and some empirical findings into a Brazilian technology-based firm, in the context of a value network with its stakeholders.

Keywords: Knowledge management, Fuzzy front-end of Innovation, Absorptive capacity, New product development, Brazilian technology-based firms

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“Thus, the task is not so much to see what no one yet has seen, but to think what nobody yet has thought about that which everybody sees.”

(Arthur Schopenhauer)

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Index of Abbreviations and Acronyms

ACAP - Absorptive Capacity

BI - Business Intelligence

FFE - Fuzzy Front-End

GPD - Gross Domestic Product

HR - Human Resources

IT – Information Technology

ICT - Information and Communications Technologies

IoT - Internet of Things

MIT - Massachusetts Institute of Technology

MVP - Minimum Viable Product

NPD - New Product Development

P&I - Products and Innovation

PMO - Project Management Office

PO - Product Owner

QA - Quality assurance

R&D - Research and Development

R&D&I - Research, Development and Innovation

ROI - Return on Investment

SECI - Socialization, Externalization, Combination, Internalization

XP - Extreme Programming

1 Introduction

Nowadays, innovation is considered one of the biggest challenges for contemporary organizations. In this context, the rapid changes that happen in organizational environments make the innovation management process an essential firm capability in generating competitive advantage. Thus, useful knowledge to the innovation process has become a necessary and disputed resource, perhaps the most important asset for businesses. However, at the same time companies are faced with this challenge, they may encounter internal conditions that limit their ability to innovate, like human, financial and infrastructure resources. This limitations results in the need to incorporate knowledge of the external environment or from external actors to its innovation processes. Thinking about this, there is a clear need to better understand the mechanisms that cause innovation. To maintain competitive advantage, companies need to launch new products on the market in the shortest possible development time (Koen et al., 2002). Consequently, the products' life cycle needs to be smaller and smaller, and technological development ever faster. To achieve these goals, companies need to know about the innovation process, its peculiarities and structure, so that they can plan right strategies aligned with their mission (Koen et al., 2001). Nevertheless, nowadays it is common, especially in IT based companies, the approach of launching the so-called Minimum Viable Products (MVP). The term was popularized in recent years by Eric Ries, a Silicon Valley entrepreneur and author, famous for being the creator of the Lean Startup movement, a new business model development strategy for startup¹ companies, focused in allocating their resources more efficiently. According the author, *"a Minimum Viable Product is that version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort"*².

In 1991, Smith and Reinertsen proposed a new way of viewing the innovation process, dividing it into 3 stages: Fuzzy Front-End (FFE), New Product Development (NPD) and Commercialization. Many studies were done over the last two sub-processes of innovation process. However, studies on the initial phase of idea generation, the fuzzy front-end, are gaining now more space in organizations and academia (Frishammar et al., 2011). Even so, the FFE is known among researchers as one of the greatest weaknesses and uncertainties of the innovation process and fundamentally determines its success (Koen et al., 2001). Artto et al. (2011) consider that the FFE is a problematic step in the innovation process, which should be explored, as it provides companies greater opportunities to improve the overall ability to innovate. In the same direction, Cooper (1993a) points out that the early stages of FFE need to be structured in a systematic way. All these assumptions brought opportunities to develop this research.

As in the initial stage of innovation process, the FFE is characterized by a high degree of uncertainty. However, it is the basis for the project choices. According to Tsai et al. (2011), the creation and sharing of knowledge drives innovation. And when it comes to the fuzzy front-end, several studies claim that an organization can substantially benefit from the optimization and active improvement of this stage, once this increases the chances of

¹ This is an organization formed to search for a repeatable and scalable business model (Blank and Dorf, 2012) or, in a complementary way, is a human institution designed to deliver a new product or service under conditions of extreme uncertainty (Ries, 2011)

² Available on <https://www.scrumalliance.org>. Access on 7 june 2015.

developing innovations. (e.g. Reinertsen, 1999; Dahl and Moreau, 2002; Boeddrich, 2004). On the other hand, some studies indicate that there are still uncertainties in both organizations and academy when talking about FFE, bringing the need of new studies and perspectives. (e.g. Chang et al., 2007; Frishammar et al., 2011).

Effectively managing the FFE is a difficult and very important challenge that innovation managers face nowadays, and approaches to handling this phase have been suggested to explore the internal and external communication flows (Kim and Wilemon, 2002). Although, to better understand knowledge management in the FFE, it is necessary to investigate more about how to capitalize knowledge assets and how to manage the shared information, both creating new or using already existing knowledge. So, the literature review conducted in the scope of this research project will focus in understanding the concepts of innovation and their importance, as well as the FFE, it's concepts, models and the knowledge flow in this phase.

Given this context of gaps and opportunities, a starting point was established for the research, with the following research question:

How does “knowledge creation” unfold within the front-end of innovation and how can we model this knowledge creation process, building on the concept of absorptive capacity?

Thus, through the literature analysis related to the knowledge management and the fuzzy front-end of innovation, with emphasis in the models related to this sub-process of NPD, this research will propose a multidimensional framework that aims at helping the future development of specific models, suitable for specific situations or organizational contexts. From the research question, the general and specific objectives were defined.

General objective:

To propose a multidimensional framework to the fuzzy front-end to improve knowledge flow along the innovation process, through the integration of Organizational Knowledge and Absorptive Capacity (ACAP) dimensions.

Specific objectives:

1. From the literature, identify knowledge management, fuzzy front-end of innovation and absorptive capacity models;
2. Identify, from the literature and market analysis, new trends on product development that could enhance the FFE process;
3. Based on the analysis of the models and trends, propose a generic framework that integrates the three dimensions mentioned in the first objective;
4. To verify the framework through a case study in a technology-based firm

The research aims to bring contributions both to the scientific literature and the corporate world. In one hand it will verify the influence of knowledge management and absorptive capacity in product innovation, the relationship of different components of these key studies with the firms' innovative capacity and propose a framework developed under empirical data, once most of the models presented in the literature are theoretical ones. In the other hand, the research will offer a prescriptive contribution and driver to managers of technological based firms.

To reach the objectives, the research was divided in some sections. Chapter 2 addresses the literature review, with focus in understanding the importance and concepts of innovation, as well as the ACAP and FFE, it's concepts, models and the knowledge flow in this phase. Trends and practices in the FFE of IT firms are adressed in Chapter 3. Chapter 4 presents the

methodological considerations to achieve the answer for the research question, using the "Design Science" approach to research. Chapter 5 shows the new multi-dimensional framework proposed in this research and an explanation of all the elements. The case study is addressed on chapter 6, through the unit of analysis' context mapping, together with the perspectives of analysis, results and verified framework elements and, consequently, an analysis of the collected data. Finally, chapter 7 brings the final conclusions, contributions and suggestion of new studies under the results of this research

2 Literature review

This literature review aims at providing the theoretical support for the development of the proposed framework that is the object of this research. In this sense, the main goal of this chapter is to give the background needed, regarding the fuzzy front-end of innovation, knowledge management, absorptive capacity and underlying themes necessary for the understanding of these key studies.

2.1 Innovation: concepts and importance

This topic intends to describe the innovation from the point of view of its importance for organizations, serving as a support for other perspectives. Given the breadth of the subject innovation, this topic also seeks to delimit the scope of the research. Innovation has always been part of human history. However, in recent decades, more precisely from the 1980s, it has received more attention from scholars, organizations and society in general. This attention is because in today's business environment organizations need to innovate to respond fast to customer demands and lifestyles, seeking to achieve the opportunities offered by technology and markets in constant changes (Baregheh et al., 2009). It happens because constant demands and environmental changes lead organizations to adapt constantly through innovation, which can be performed in terms of products, services, operations, processes, people or business model (Baregheh et al., 2009).

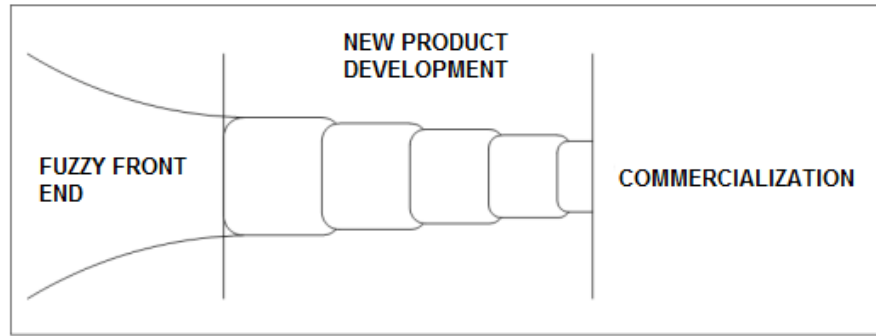
Innovation represents the main renovation process of any organization, once their survival and growth perspective is influenced by the changes that organizations offer to the environment, through its products, and the ways in which it creates and provides these offerings (through innovation process) (Bessant et al., 2005). The importance of innovation can be compared with that given to quality in the late 60's. It is directly related to the organizations sustainability.

Given the importance of innovation, it is interesting to conceptualize it, trying to understand its process. According to the Oslo Manual:

An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. (OECD, 2005, p. 46)

The expansion of the presented definition enables a new point of view, in order to form a broader understanding. Thus, based on an analysis of the literature definitions and seeking for an innovation definition that represents its essence, Baregheh et al. (2009, p. 1334) claim that *"Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace"*. This concept refers to innovation as a process that leads to the product development of the organization, as shown by the definition of the Oslo Manual.

In this context, a strong relationship was created between the innovation and new product development studies. As mentioned before, Smith and Reinertsen (1991) proposed a new way of viewing the innovation process, dividing it into 3 sub-processes, according to Figure 1.



Source: Adapted from Koen et al. (2001, p. 51)

Figure 1 The three sub-process of innovation process

Decisions taken at the beginning of a process tend to give directions to it and strongly influence the outcome. Thus, it is clear that an improvement in this stage has great impact on the process as a whole (Reid and Brentani, 2004). Based on this, this research proposes an emphasis on the early stage of the innovation process. This beginning, called Fuzzy Front-End, will be handled in further detail in the following paragraphs.

2.2 Fuzzy front-end: concept and models

As mentioned before, the term "fuzzy front-end" was popularized by Smith and Reinertsen (1991), which consider this as the first stage of the new product development process. The word "fuzzy" indicates that this stage can be chaotic, unpredictable and uncertain (Koen et al., 2001). However, beyond that, other terms in the literature are also used to indicate this stage of the innovation process. The most used are: "fuzzy front-end" (Flint, 2002; Koen et al., 2001; Koen et al., 2002; Kim and Wilemon, 2002), "front-end of innovation" (Khurana and Rosenthal, 1998), "front-end process" (Nobelius and Trygg, 2002), "front-end of new product development" (Rozenfeld and Forcellini, 2006), "early phases of innovation" (Muhdi et al., 2011) or "pre-development" (Cooper, 1988).

Koen et al. (2001) states that this phase involves activities that occur before the formal and structured process of development of new products. Khurana e Rosenthal (1998, p. 59) complement, saying that this stage *"include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning and executive reviews"*. For research purposes, the definition of idea and opportunity used here are from Koen et al. (2002). For the authors, an opportunity is *"a business or technology gap, that a company or individual realizes, that exists between the current situation and a envisioned future in order to capture competitive advantage, respond to a threat, solve a problem or ameliorate a difficulty"* (p. 7). In its turn, an idea is *"the most embryonic form of a new product or service. It often consists of a high-level view of the solution envisioned for the problem identified by the opportunity"* (p. 7).

Regarding FFE models, there are many of them in the literature. However, through a systematic review of the most mentioned models and others considered relevant to this research, a summary table to discuss their main contribution to the literature and to this investigation will be presented, listing their main features, inputs, type of process flow, focus and the output or expected result of the FFE. The table 1 shows a comparison of the analyzed models and aim a better understanding in how to conduct the activities in this phase.

Table 1: Comparison of fuzzy front-end models

MODEL	MODEL'S ORIGIN	FEATURES / CONTRIBUTIONS	INPUTS	PROCESS FLOW	FOCUS	EXPECTED RESULT OF FFE
Cooper (1993b)	Theoretical	States that one of the front-end goals is to create well-defined product concepts prior to development, once the innovation process requires a clear concept to proceed.	Ideas	Linear	Product	A product concept and feedback to review the product after development
Khurana and Rosenthal, (1997, 1998)	Empirical	Highlights the importance of an alignment between the front-end and the organization's strategy, through an integrated view of the front-end of innovation.	Ideas and opportunity identification, according to Product & Portfolio strategy	Linear	Product	Opportunity identification
Koen et al. (2001)	Theoretical	Represents the process starting with an idea or identified opportunity. Also includes strategy as influencing the process, together with organizational capabilities and external actors.	Idea or opportunity identification, according to the culture and leadership of the organization	Iterative	Product	Product concept and intellectual property
Flynn et al. (2003)	Theoretical	Brings creativity as an important key to stimulate the ideas creation.	Organizational strategic direction	Linear	Product and services	Ideas
Crawford and Benedetto (2006)	Theoretical	The model starts with an idea identification and ends with the approval or not of a project to develop. The focus is on the three stages of pre-development, which includes product strategy, idea generation and new	Opportunity identification and selection	Linear	Product	Product concept to evaluate

		projects portfolio management.				
Whitney (2007)	Theoretical	The model describes the importance of analysis and control during all the process, through feedback.	Ideas and opportunity	Iterative	Product, with focus on technology	A new or improved technology, ready to be developed
Brem and Voigt (2009)	Empirical	Show the importance of an integration between market and technology visions.	Ideas (creation and selection)	Iterative	Services	Ideas for implementation
Kurkkio et al. (2011)	Empirical	It addresses the front-end of new processes development	Ideas (generation and refining)	Iterative	Process	Process concept

Source: Prepared by the author based on the main FFE models found in the literature.

From the analyzed models, some points in common or differences were identified between them. Table 1 show that ideas are inputs in most of the FFE models. Some of them have taken ideas, creation and ideation and others bring both ideas as opportunities identification. As outputs, we can see a project, a concept, an innovation or even feedback. In the influencing factors were identified: strategy, environment, culture, time, information (internal and external), creativity programs, motivation, opportunities identification, knowledge sharing, policy, research and development.

Regarding the relevance, most models bring some stimulus that encourages creativity and the idea generation, as well as a way to select it. Most models are in the context of innovations in product. Some include products and service and others are limited to create a new technology or improve an already existent one (i.e. Whitney, 2007).

Concerning the ideas bank, only two models that specify how the portfolio of ideas will be stored were found. Cooper et al. (2002) report that the ideas stored in the bank of ideas should be available to all employees. Thus, they can contribute with improvements, and the manager can analyze this periodically to bring back to the evaluation process those ideas that were improved. According to Cooper et al. (2002), if there is not a bank of ideas, potential ideas will be lost. So, the company must have a bank of ideas and a repository for ideas that were rejected, to avoid waste of ideas and thereby increase process efficiency. Kim and Wilemon (2002) also suggest that the organization describe and justify the reasons for rejecting an idea,

because a change in the business environment can reactivate an idea that was previously rejected.

The models present, which one in its context, three main elements: ideas, opportunities and concept. In this sense, the model of Koen et al. (2001), which was used later by Whitney (2007), translates the relationship of these three elements in an interesting way, emphasizing the interactions between them. Koen et al. (2001) say that the process can start with idea generation or opportunity identification, considering that an idea requires one or more opportunities, as well as an opportunity can require one or more ideas.

Although some models are not classified as interactive, once this movement is not properly explained in the authors' work, most models recognize that each activity influence the others.

Several models, with emphasis on Khurana and Rosenthal (1997), highlight the importance of an alignment between the FFE and the organization's strategy. Koen et al. (2001) include a process engine in their FFE model, considering the leadership and organization culture as drivers of this process. As well as Khurana and Rosenthal (1997), Koen et al. (2001) include the strategy as an influencing factor of the process, along with the organizational capabilities and the external world (e.g., distribution channels, customers and competitors). In a strategic sense, the evaluation of the competitive situation (scan and environmental analysis) is an activity that needs to be addressed during the FFE (Kurkkio et al, 2011).

In addition, some models show the importance of integration between the market and technology views, considering different levels according to specific sectors. In this sense, the attention should be given to the research done by Brem and Voigt (2009), as these authors worked precisely on this relationship.

2.3 Knowledge flow in the fuzzy front-end

Harkema (2003) defines innovation as a process of information, aiming the creation of new knowledge to drive the market and develop effective solutions. According the author, for an innovation to become a reality, it is necessary to apply and mix the knowledge of various organizational areas, encouraging the planned return. Thus, the level of organizations maturity can also be represented by the acquired and used knowledge to improve the innovation process. A team that conducts an experiment, being this successful or not, will learn something during the project that may be useful in the future.

Nonaka and Takeuchi (1999) cite, as an example, the knowledge about management acquired by teams and managers. This tacit knowledge can be organized and transformed into explicit. In addition, this knowledge can even be valuable to an innovative organization, especially for multidisciplinary teams that require integration and good leadership. The organization also needs knowledge to improve productivity and develop new products quickly, with less probability of errors.

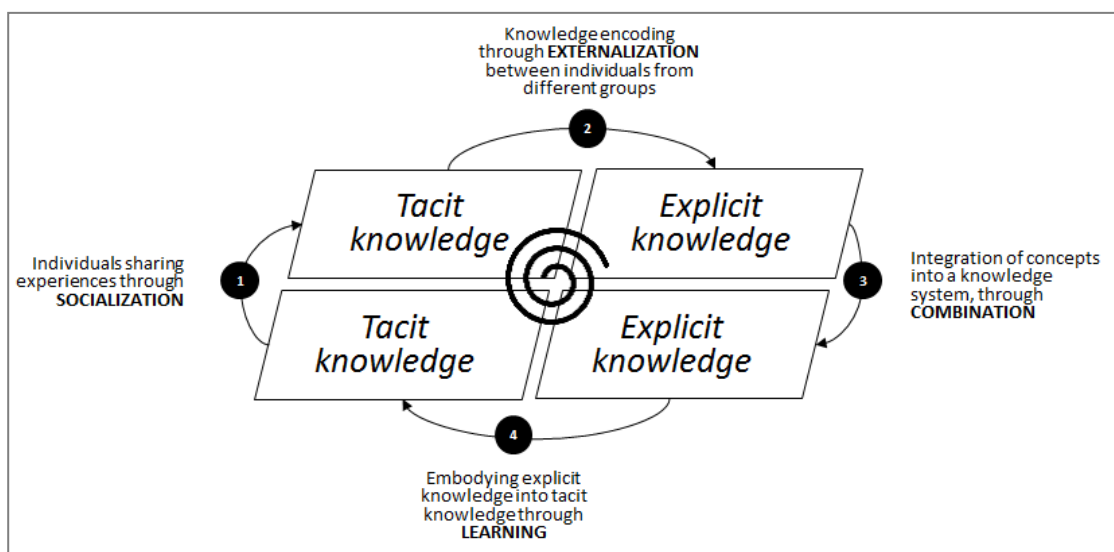
Because of this, the new knowledge management practices become essential for innovation to occur in organizations. According to Davenport and Prusak (1998), the most innovative companies are those that have the greatest power to create and manage their new knowledge. In this context, knowledge management is a practice that should be part of the organizational culture, thus facilitating the innovation process.

The knowledge creation process starts when a group of individuals shares their knowledge about a subject. Most of this knowledge is classified as tacit, which is the basis of the organizational knowledge creation process, including knowledge about market, demand

requirements, information on new technologies, personal skills etc., that can be very useful for the innovation development (Von et al., 2000).

Nonaka e Takeuchi (1995) point out that this tacit knowledge, embedded in the experience of an individual, is difficult to formalize. This, to be transferred, must be first converted into explicit knowledge. According to these authors, this conversion occurs in four ways, through the interaction between tacit and explicit knowledge, which culminated in the SECI model of knowledge creation, as described below and the Figure 2:

1. **Socialization:** tacit to tacit knowledge;
2. **Externalization:** tacit to explicit knowledge;
3. **Combination:** explicit to explicit;
4. **Internalization:** explicit to tacit.



Source: Adapted from Nonaka e Takeuchi (1995, p. 57)

Figure 2 The knowledge creation process

Therefore, it is very important to create an environment that stimulates the knowledge creation and sharing, as well as the training that helps in learning of employees (Dalkir, 2005).

Another key aspect of the knowledge creation and innovation process refers to the firm's ACAP. Nieto and Quevedo (2005) state that companies have different capacities to innovate, precisely because their ability to absorb knowledge is different. Although there are other factors that can lead to different innovative performances, the absorptive capacity may be an important driver to understand the differences of asymmetric use of knowledge. From a conceptual point of view, Cohen and Levinthal (1990, p. 128) define ACAP as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends". After their studies, the process of absorbing knowledge becomes an essential element for achieving competitive advantage because, according to the authors, the higher the absorptive capacity, the greater the innovative capacity of the firm. Thus, the ability to exploit external knowledge becomes an important component of innovation capabilities.

The foundation of absorptive capacity notion is that the organization needs prior knowledge to assimilate and use new knowledge, which can affect innovative performance in an uncertain

environment (Cohen and Levinthal, 1990), which is very common, for example, in the FFE phase. In order to validate this construct empirically, Zahra and George (2002, p. 186) extend the concept of ACAP, considering it as “*a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability*”. For Todorova and Durisin (2007), when new knowledge fits the cognitive processes existing in the company, the assimilation occurs, and then it is incorporated. It means that the company can interpret and understand it with existing cognitive structures, because it is compatible with the existing context and with a prior knowledge. However, when new knowledge is perceived as incompatible with prior knowledge or when new situations cannot be changed and absorbed by the existing knowledge structures, the company has to build new cognitive structures through the transformation.

Although the capacity to absorb external knowledge can generate significant benefits, several internal and external factors can have different effects in the absorptive capacity dimensions and can lead to different results of innovation and performance.

2.4 Final considerations

With the analysis of the FFE models, it was possible to realize the dominance of theoretical models, where few of them were developed from empirical data. This further increases the relevance of the case study conducted in this research.

The literature review also confirms that innovation process is influenced by many internal and external factors of a company and this has led the author to ask if it would be possible to identify a vision of a process that could operate across multi-dimensions. With this objective in mind, topic 5 will propose a unifying conceptual approach, which could link knowledge management with the fuzzy front-end of innovation as a multidimensional process in the organizational level.

3 Front-End of Innovation Practices in IT Firms.

3.1 Introduction

Information Technology (IT) is one of the fastest growing and develops areas worldwide. It is also one of the most rapidly changing segments. The IT market launches trends all the time and creates new needs, besides supplying some existing ones. In its turn, the innovation in the IT sector, considering its transformational and horizontal penetration character in all other economy sectors, has been a major enabler to generate value to the businesses.

Considering this, IT companies operate in a relevant way in building a more competitive power of the Brazilian business sector. According to a study of the IDC Brazil³, the Brazilian Information and Communication Technology (ICT) market is expected to hit \$ 165,6 billion in 2015, with 5% growth compared to last year⁴, even with the apparent crisis the country is experiencing. The impulse will be given by the third platform - technologies such as the Internet of Things (IoT), 3D printing, cognitive systems, robotics and neural interfaces will be the basis for accelerating innovation and business in companies. With this, Brazil is expected to reach, by the end of this year (2015), the sixth position as the most important market in the world in ICT.

Considering the current environment of economic crisis, it is the new products launched on the market that can create better business opportunities. Therefore, and allied to the Research and Development (R&D) investments, it is necessary to point and understand the main challenges, practices and trends in the segment in order to enable IT professionals and companies with greater insight in developing new applications, such as improved processes or products .

3.2 Practices in IT Firms

With the globalization advent and, consequently, the fierce competition market, companies are seeking for factors that differentiate themselves from the others. The relentless pursuit for cost savings, as well as reducing the profit margin in order to obtain impact on costs, are no longer differentiating components, since these benefits are not sustainable over time. The era of information and knowledge, combined with the technological developments, the internet revolution and dissemination of online communities, have brought a set of new challenges to the business community. The new challenge for companies is: more and more innovative products, with lower costs and faster time to market.

Considering this, the agility, ease of adaptation and the ability to offer new products and services also become important competitive advantages and, in some cases, a prerequisite for the businesses survival. Nevertheless, agile methodologies have also been identified as an alternative to traditional approaches to the NPD process, mainly in technology companies.

The term "Agile Methodologies" became popular in 2001 when seventeen experts in software development processes, representing the Scrum methods (Schwaber and Beedle, 2001),

³ International Data Corporation Pesquisa de Mercado e Consultoria Ltda

⁴ Source: <http://www.meioemensagem.com.br/home/marketing/noticias/2015/01/22/TI-deve-movimentar-US-165-bilhoes-no-Brasil.html>. Access in 20 august 2015.

Extreme Programming (XP) (Beck, 1999) and others, established common principles shared by all of these methods. As a result, the Agile Alliance was created and the "Agile Manifesto"⁵ was established. The key concepts of "Agile Manifesto" are:

- Individuals and interactions rather than processes and tools;
- Executable software rather than documentation;
- Customer collaboration rather than contract negotiation;
- Fast response to changes rather than following plans.

"That is, while there is value in the items on the right, we value the items on the left more".
(Agile Manifesto)

Most agile methodologies have nothing new (Highsmith and Cockburn, 2001). What differentiates them from traditional methodologies are the focus and values. The idea of agile methodologies is the focus on people rather than processes or algorithms. In addition, there is a concern about spending less time on documentation and more with the implementation.

In the last decade agile methodologies are gaining space in the Information and Communication Technology market. Several surveys show the good results achieved by some companies, for example, the research conducted by Scott Ambler⁶ in 2008 reported that 82% of companies have seen improvements in productivity, while 77% showed improvements in product quality and 78% realized increase in the stakeholder satisfaction. In 2013⁷, Ambler reports a success rate of 65% on the projects using agile methodologies. Another survey⁸, conducted by Version One regarding the adoption of agile methods, shows that 88% of the respondents said that their organizations were practicing agile development in 2013, 4% more comparing to 2012.

A fundamental premise of agile methodologies is the recognition of the users' difficulty to know, in advance, the features they would like to have in the system. Therefore, these methodologies adopt a bottom-up approach, creating favorable conditions for the interactions and feedbacks between users and the system developers throughout the project. The real users' needs and not the "concept" of an ideal system is the key point of the project's success.

Some companies still use the traditional "waterfall" methodology for software development, also known as sequential or linear, once it is based on a series of steps where one only starts after the end of the step before it. But unlike traditional methodologies, which have well-defined and separate phases, the phases of planning and development interact throughout the project in the agile methodologies, thus allowing a constant interaction between users and developers. This enables a nonlinear model, which emphasizes the retroaction on the later stages preceding previous stages and an interaction between planning and production.

⁵ The Agile Manifesto. Available on: <http://agilemanifesto.org>. Access in 22 august 2015.

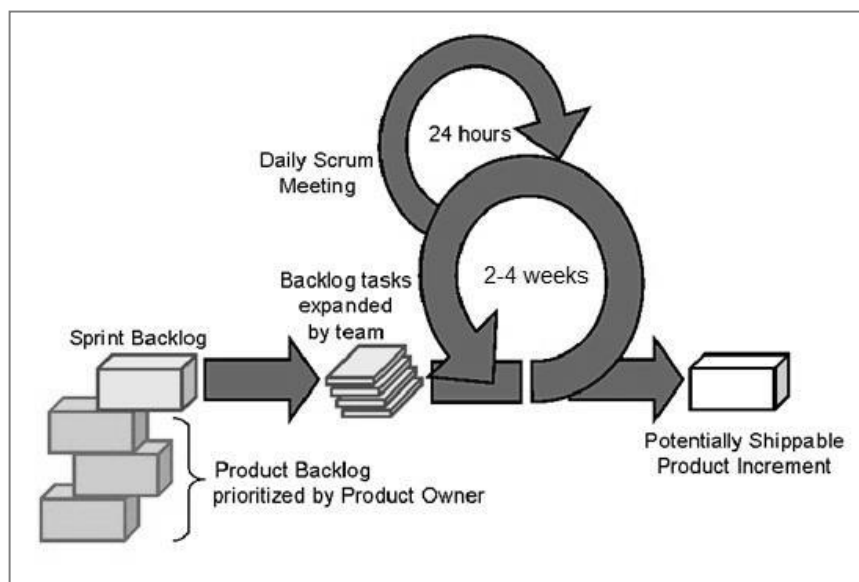
⁶ Scott Ambler, Agile Adoption Survey 2008. Available on <http://www.ambysoft.com/downloads/surveys/AgileAdoption2008.ppt>. Access in 7 June 2015.

⁷ Scott Ambler, 2013. IT Project Success Survey Results. Available on <http://www.ambysoft.com/surveys/success2013.html>. Access in 7 June 2015

⁸ 8th annual state of agile survey, 2014, VersionOne. Available on: <https://www.versionone.com/pdf/2013-state-of-agile-survey.pdf>. Access in 08 September 2015.

Agile methodologies are designed to accelerate the development of software for continuous process improvement, generating benefits, such as increase communication and team interaction, daily organization to achieve the set target, prevent failures in the development, rapid responses to changes and significant increase in productivity. The Scrum, in turn, is a process of iterative and incremental development to project management and agile software development. In Scrum, the projects are divided into cycles called Sprints. Each sprint represents a set of time within a group of activities that should be executed. In this process there are 3 main roles and responsibilities: The Product Owner (PO), the Scrum Master and the Scrum Team. The Product Owner is *"the person responsible for managing the Product Backlog so as to maximize the value of the project. The Product Owner represents all stakeholders in the project"*. (Schwaber and Beedle, 2001, p. 113) The Scrum Master is *"the person responsible for the Scrum process, its correct implementation and the maximization of its benefits."* (Schwaber and Beedle, 2001, p. 113) The Scrum Team is *"a cross-functional group of people that is responsible for managing itself to develop software every Sprint."* (Schwaber and Beedle, 2001, p. 113) The team may also have a "working framework", called Kanban⁹, to organize the list of activities (Product Backlog) in the Sprint, separating them in four states (which can vary with each project): To-Do, Doing, Testing and Done. This "framework" is very productive and visual. After a simple look at it, it is possible to visualize the Sprint progress.

In general, the central idea is to work with short iterations. Each iteration delivers a final and complete product ready to be used, which contains a new subset of features implementation. The use of short iterations allows users and customers to make an assessment of the system as soon as an initial version is put into production. At this point, users, customers and developers decide what features should be added, which should be modified, and even, which must be removed from the system. On this way, the system is developed in the most iterative way as possible. This process can be seen in the Figure 3.



Source: Adapted from Schwaber and Beedle (2001, p. 11)

Figure 3 Scrum software development process

⁹ Kanban is about choosing the right work at the right time, using the same Lean principles from manufacturing and applying it to individual and team work. (Benson and Berry, 2011)

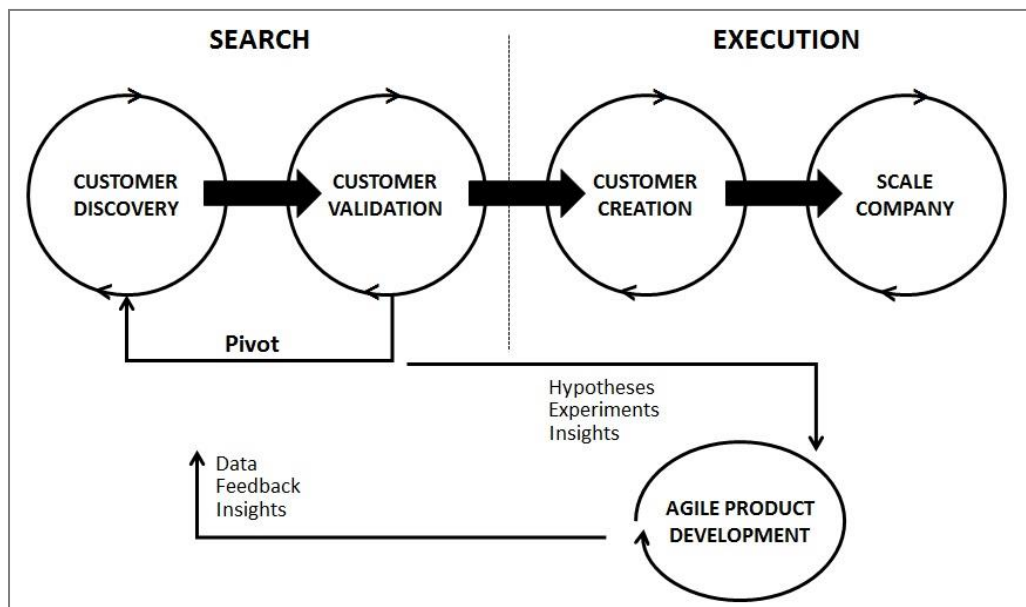
3.3 Another Point of View into the Agile Development

Another important issue to consider in the Agile Development is the consumers. They are increasingly demanding, sophisticated and interventional (Ancona et al., 2008) and have been recognized as part of the innovation chain, becoming central engines of a market in constant mutation (Franke and Shah, 2003; Moon and Sproull, 2001).

"Users have been found to be the inventors of reliable prototypes of what later became successful products in different markets [...]. End users, likewise, seem to be willing and able to develop substantial ideas, concepts and prototypes for new products"(Tietz et al., 2004, p. 3)

These end users are used to share innovations spontaneously in the context of their communities. These innovators-consumers, also called Lead Users, are valuable to businesses, because they have the consumer perspective by benefiting from the use, getting to see beyond the R&D teams.

Considering this, the literature for startups has addressed the "customer" issue. Blank (2007), Ries (2011) and Cooper (2013) works have put the customer at the center of the process for innovative businesses. Blank (2007) brings the important concept of hypothesis for the world of startups, which are generally outlined by business model canvas tool (Business Model Panel), a single vision divided into nine blocks. Hypothesis, according to Blank (2007), are assumptions that entrepreneurs should do at the beginning of the business model and are part of the "Customer Discovery" process. However, they only gain validity when they are tested in the market. According to Blank (2007, p. 28), *"customer discovery goal is to turn the founders initial hypotheses about their market and customers into facts"*. The customer development process is pictured in the Figure 4.



Source: Adapted from Blank (2007, p. 16)

Figure 4 The Customer Development Process

The Lean Startup was designed in 2011 by Eric Ries, based on his previous experience working in several startups. The concept of Lean Startup is based on Customer

Development¹⁰ plus the Lean concept, created by Toyota to leave the production process leaner, avoiding waste of any resource type. The main premise of the Lean Startup is that the higher the hypotheses validation speed, the lower the cost of each big iteration - in this way the Startup is able to validate or discard important assumptions about the product or market. The Lean Startup methodology uses a more immediate approach to the client to test their hypotheses. They ask potential users, buyers and partners for feedback on all elements of the business model, such as features, prices and distribution channels. The emphasis is on the speed of the feedback which will enable the rapid construction of a MVP, that will also be used as an input for new customer feedbacks, allowing to review the hypotheses and execute a new cycle of development. This process is, in fact, very much about agility and integrates with the above SCRUM vision, with sprints used to validate successive MVPs.

3.4 Other eligible approaches

Innovation is not a new theme in organizations, particularly in sectors that rely heavily on R&D to grow or even stay on the market. However, growth opportunities on the one hand, and market competitiveness on the other, are driving organizations to rethink their approaches in order to amplify the impact with customers, shorten the development lifecycle and optimize the investments. The task of developing a new product or new service within R&D&I (research, development and innovation) involves different functions within the company, sharing of scarce resources as well as managing tight deadlines. In summary, the product development activity is complex and interferes in normal activities of the company operation. For this and other reasons the NPD process seeks to achieve a high level of efficiency.

In several R&D&I processes, the engineering systems' perspective is based on systemic thinking (Josef Oehmen, 2012). Systemic thinking occurs through discovery, learning, diagnosis, and dialogue that leads to the detection, modeling and talk about the real world to better understand, define and work with any system. The approaches presented below are derived from this systemic thinking and, although they have gained visibility in recent years, its origin goes back to the 70's (Visual Thinking and then Design Thinking, with the origins in Stanford) and 80's (Lead Users, with the origins in MIT Sloan). Studies, like Churchill et al. (2009) highlight the excellent results based on the Lead User approach, with probability of 80% of success, compared to traditional methods and sales generation potential 8 times higher, in a lower time of development compared to the classical methods. Olson and Bakke (2004) points out that 3M deepens enough discussions in the initial phase, aiming at minimally mature project goals, assumptions and initial hypotheses, avoiding projects with excessively vague scope.

Hippel (1986) - Professor at MIT (Massachusetts Institute of Technology) and scientific director of the Danish User-Centered Innovation Lab - set the Lead Users of a new or improved product, process or service as those who: (i) face the needs that will be general in the market, but face them months or years before the consumption is widespread and (ii) are positioned to significantly benefit from the solution of their needs.

¹⁰ The concept of Customer Development was created by Steve Blank as opposed to the conventional management model. It is an iterative process that starts from the premise that "the facts are outside the building (workplace)" and that the entrepreneur should validate their fundamental assumptions of the market as soon as possible (Blank and Dorf, 2012). It is extremely important to find out who will be the first customers and which markets they are inserted, making the "customer development" a parallel process and with the same importance of product development.

This methodology of new products or services concept identification is based on the idea that the best insight into the needs of new products or services arises from the perception obtained by Lead Users. These users can be systematically identified and the information they have can be used for purposes ranging from the development of new products and services to the development of corporate strategies (Hippel and Riggs, 1996).

Hippel and Cornelius (1991) concluded that consumers and users often selected as a source of information for the development of new products or services have an important limitation: its perception of new requirements and potential solutions to these questions come from their own daily experience. Additionally, traditional methods of generating ideas for new products, processes or services are made based on information from traditional consumers, taking as a starting point the comparison with families or categories of products or services that already exist. This restriction, necessary to limit the attributes to a manageable number, tends to limit consumers perceptions to the attributes that fit the categories of existing products (Hippel, 1986).

Innovation processes, focused on users applying the Lead User methodology, follow the following steps, obtained after years of improvements (Olson and Bakke, 2004):

- **Phase 1** - Project planning and multidisciplinary resources allocation
- **Phase 2** - Determination of the main trends
- **Phase 3** - Reference users identification (Lead users)
- **Phase 4** - Development of innovative ideas and goods and services concept (ideation)
- **Phase 5** - Prototyping, testing and concepts validation

Recently, another methodology of the innovation process, also user-centric, gained visibility in the world, including Brazil. Called Design Thinking, it indicates that Design is a creative, iterative and interactive process where designers create relations between concepts/ideias to solve a problem. (Razzouk and Shute, 2012). Although the company IDEO did not invent the term, it was one of the 1st opinion leaders on the subject. Currently, there is great interest in Design Thinking and cognitive design, both in the academic and business world. The methodology is based on three main areas:

- **Inspiration:** where insights of all kinds are collected;
- **Ideation:** where insights are translated into ideas;
- **Implementation:** where the best ideas are developed in a concrete action plan, fully prepared.

At IDEO the following principle drives the dynamics of projects: "Fail often, to succeed sooner"¹¹.

Some global leaders in their segments as Apple, SAP, Google, Intel, Amazon and others, come extending the concept for "Design Led Innovation", where all or most of the organization assumes that the strategic initiatives are formulated and implemented according to the concept of Design Thinking, spreading the need for executives to be Design Thinkers.

¹¹ Available at <https://www.youtube.com/watch?v=M66ZU2PCicM>. Access in 30 August 2015

3.5 Final considerations

The latest version of the Standish Group study¹² on IT projects indicates that, despite a fall in recent years, 74% of projects in the industry extrapolate time and 59% exceed the allocated initial cost. The study considers projects where the total cost is below \$ 1 million, although indicates that projects exceeding this value have even greater chances of non-compliance with budget and deadline.

Another interesting fact pointed out by the study is the few use of the features/functions delivered by the projects. In most cases, only 20% of the features are continuously used by end users and about 30% were used intermittently with the remaining 50% almost or never used. With this in mind, it is not difficult to conclude that if it were possible to find out, in advance, which of these features will not be used - probably because they do not make sense or are unnecessary - all the parameters above would be reduced. Projects would be smaller, it would cost less, it would have more chance of being delivered on time and thus allow the organization to respond more quickly to the market and the demands of their customers.

The most important question here is how to innovate in this world where the projects constantly fail, the cost overruns and people do not know what to do. There is not a simple or final answer, but the last ten years has presented some answers that follow the same philosophy: Make less.

When the subject is innovation, technology and new product development, there is not a recipe for repeatable innovation. But making less can take the organization to a point where experimentation becomes possible and there is a possibility to change the course without penalizing profitability and business continuity. Also, it is important to create environments that encourage loyalty and learning.

Ronaldo Ferraz, Managing Director of ThoughtWorks Brazil and expert on innovation and fast deliveries, gives some tips to organizations that want to keep relevant¹³:

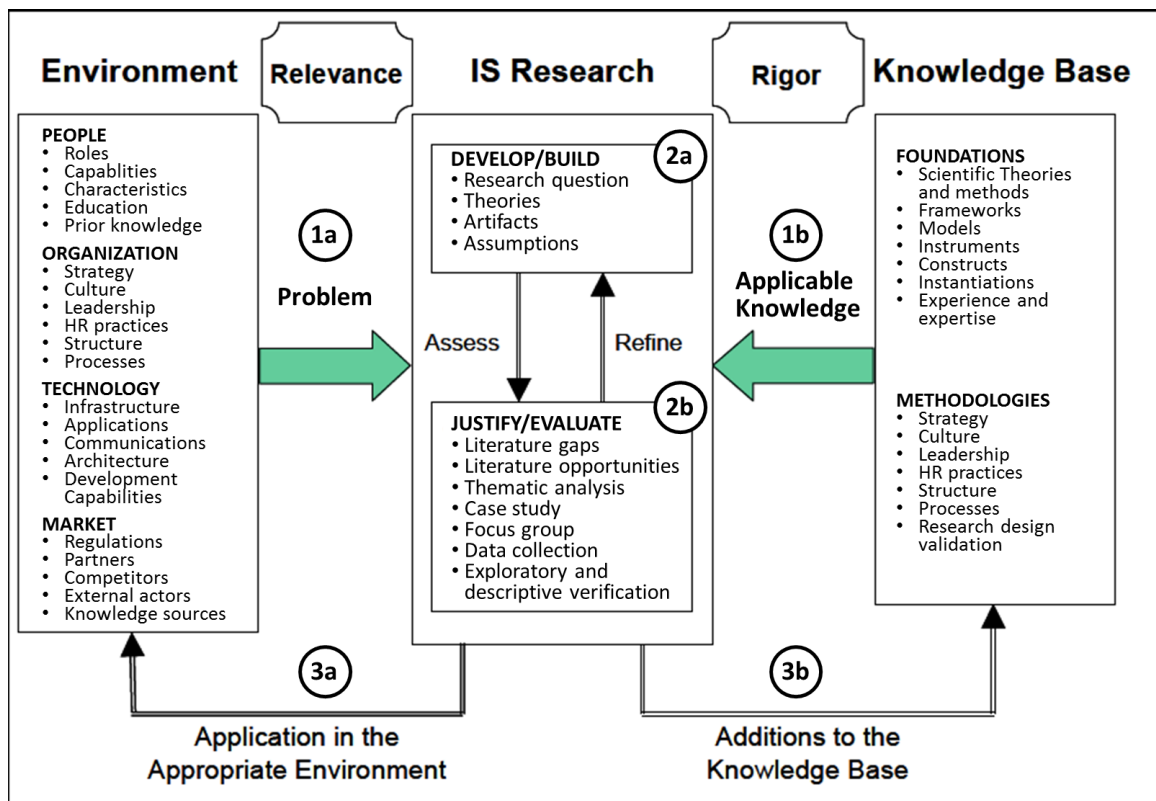
- Start a disciplined experimentation process: For an innovation project, identify the minimum product that enables a market test and prove it. It is important to get feedback and repeat the process until have the final product.
- Prototype: Prototypes are essential for experimentation and allow transform the development process into something based on real facts.
- Eliminate waste: Discard unused feature/functions or customization whose cost exceeds the project budget is very important for success.

¹² The Standish Group Report Chaos - Project Smart, 2014. Available on <https://www.projectsmart.co.uk/white-papers/chaos-report.pdf>. Access in 20 August 2015.

¹³ Available at <http://www.thoughtworks.com/pt/insights/blog/faca-menos-uma-estrategia-solida-de-inovacao-em-ti>. Access in 30 August 2015

4 Methodological considerations

From the analysis of the main FFE and Knowledge Management models found in the literature it was possible to realize a predominance of theoretical models and few of them developed under empirical data. Moreover, as mentioned before, other studies indicate uncertainties in both organizations and academy when talking about FFE, bringing the need of new studies and perspectives. To approach this research we followed the Design Science Approach (pictured in Figure 5) (Hevener et al., 2004). “*Design science addresses research through the building and evaluation of artifacts designed to meet the identified business need*” (p. 79-80). In the scope of this model, we propose a Framework for the FFE of innovation.



Source: Adapted from Hevner et al. (2004, p. 80)

Figure 5 Conceptual framework for understanding research combining behavioral science and design science paradigms

This framework was built considering the gaps identified in previous chapters (“Knowledge Base”) and the author professional experience of more than 8 years working with new product development in a technology-based company (“Environment”). In this context, the following research question emerged:

How does “knowledge creation” unfold within the front-end of innovation and how can we model this knowledge creation process, building on the concept of absorptive capacity?

This research question, in the context of the Design Science, has led to use the case study methodology to validate the proposed framework for the FFE of Innovation. This exploratory

case study unfolds in a Brazilian technology-based firm, that uses agile methodologies, also seeking opportunities for improvement from this research. Because this is still a verification, exploratory and descriptive, a focus group approach, with interviews, will be used in this research. A focus group is a group interview widely used in exploratory studies, with the purpose to provide better understanding of the problem, generate hypotheses and provide elements for the construction of data collection instruments (Gil, 2010).

The IT sector was selected for this analysis due to its relevance. According to the survey conducted by Deloitte¹⁴, which annually identifies the 250 small and medium fastest growing companies in the country and makes an x-ray of these businesses, IT companies are on the top of the list. 27% of the fastest growing companies in Brazil are information technology ones.

The chosen unit of analysis is a Brazilian technology-based firm that develops mobile solutions. Founded in 1999, the company was pioneer in the mobile telephony value added services and technologies in Brazil.

In 2015 the company was named the 52nd best IT Company in Brazil to work, by the Great Place to Work Institute (3rd best in its state) and, in 2014, was in 70th position among the 250 fastest growing SMEs in Brazil. The choice of the unit of analysis was influenced not only by these factors, but also because of ease of access. The author of this research has worked for 6 years in the company (3 of them as product and innovation coordinator).

According to data from “Serviço Brasileiro de Apoio às Micro e Pequenas Empresas”¹⁵ (SEBRAE, 2014), it was estimated that in Brazil there were 5.7 million micro, small and medium enterprises in 2012, which corresponds to 99% of companies, 60% of occupations and 20% of GDP (Gross Domestic Product). Besides, SMEs have specific characteristics that distinguish them from larger companies; this data demonstrates the importance of them in generating wealth for the country's economy. If in the one hand its organizational structure enables faster reaction to a context of instability and rapid changes, on the other, it is very important to be aware to face these difficulties and remain competitive in the long term. And for this, they will be required to integrate certain capabilities and innovative performance to achieve the desired results, considering that new ideas can be used as innovation in product management, stemming from different external sources, that can be customers, end users, universities, research institutes, competitors etc.

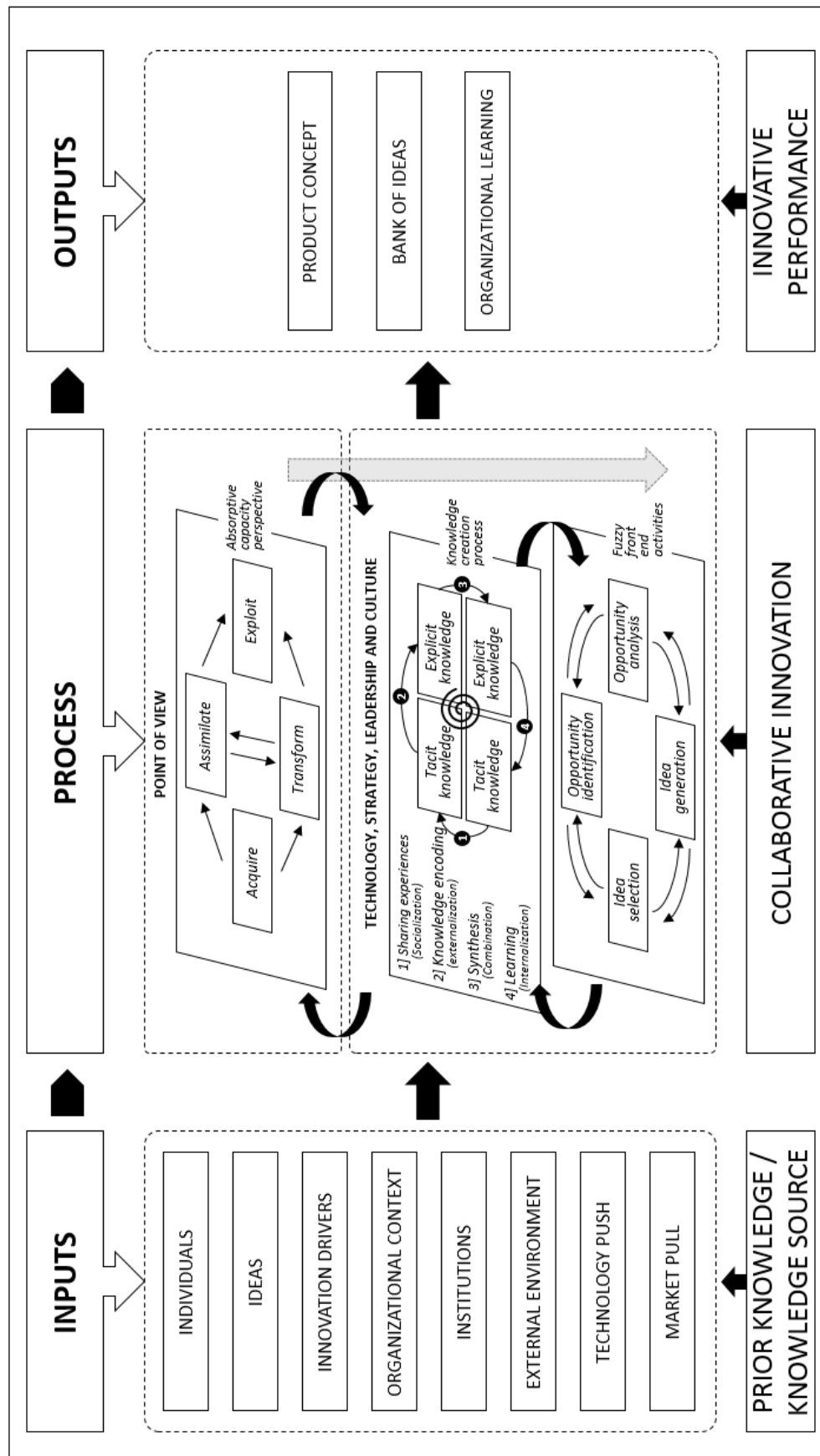
¹⁴ Available on <http://www2.deloitte.com/br/pt/pages/strategy/articles/pmes.html>. Access in 20 August 2015.

¹⁵ Brazilian Support Service for Micro and Small Enterprises

5 Proposal of a multidimensional framework

This chapter aims at presenting the proposal of a multidimensional framework to improve the knowledge flow and innovation process in the fuzzy front-end activities. The proposal was based, mainly, on the studied models, presented in the previous sections and their respective influencing factors. The proposed framework is illustrated in Figure 6, with three sets of main elements that make up the process: 1) The "inputs", considered in the proposal as prior knowledge acquired by individuals linked to the organization or internal and external sources of knowledge, that have influence and direct impact in the fuzzy front-end activities; 2) the innovation process itself, which takes place collaboratively, including the fuzzy front-end activities and knowledge management processes; 3) the outputs of these processes, directly linked to the innovative performance of the organization.

The details of the framework will be outlined in three parts. The first describes the input elements and how they influence the innovation process, the second describes the elements and activities of the presented processes and the third describes the output elements and how they result from those processes.



Source: Prepared by the author based on the gaps and opportunities found in the literature

Figure 6 Multidimensional framework to improve knowledge flow and innovation process at the fuzzy front-end

5.1 Understanding the framework: the inputs

From a micro to a macro perspective, several elements that directly influence the fuzzy front-end activities were listed as inputs. These are considered prior knowledge brought by internal and external actors or sources of knowledge, which also influence the firms' absorptive capacity. The **individuals**, whether internal or external to the organizations, can generate **ideas** for new products or services to be developed. This systematic process of creating and capturing ideas is based on requirements defined by the organization and includes components related to creativity and the organizational structure to support the process, this latter affected by **innovation drivers**. The innovation drivers are presented here with the same idea that Koen et al. (2001) calls "engine" (leadership and culture) and "influencing factors" (technology and the organization strategy). The decision to classify them as innovation drivers is due to the understanding that the innovation process will be driven by these factors. Khurana and Rosenthal (1998) also emphasize the need to consider **organizational context** of the firm in the FFE activities. Some of these contextual factors are team experience, innovation support and level of product radicalness. All this comprises the internal environment, where employees are the key actors. Whitney (2007) adds that this organizational context has factors that limit the system operation, as for example the **institutions**, considered in this framework as government policies, laws and regulations. In addition, other **external environment** factors can also have great influence on the innovation process and serve as important sources of knowledge and information. The actors of this environment are end users, customers, suppliers, competitors and others. **Technology-push** and **market-pull** approaches are also relevant for innovation process. For Brem and Voigt (2003) the market and technology vision should coexist, but in different degrees, according to specific sectors.

5.2 Understanding the framework: the process

The proposed process for the **fuzzy front-end of innovation**, based on the iterative FFE model of Koen et al. (2001), can start with a generated idea or opportunity identification. The iteration between them should take place until the organization identifies that there is a strong association between one or more ideas and one or more opportunities, through an analysis. In this sense, the selection should be a constant activity in all stages of the process (Whitney, 2007). A strong association means a strong alignment with business objectives, interpreted by innovation drivers: **technology available, organization strategy, leadership and culture** (Koen et al., 2001). Eling et al. (2013) argues that intuition can be very useful in decision-making during the FFE. When used correctly, this can help team members to increase the creativity in developing a product concept. Moreover, multidisciplinary knowledge in the team can generate better outcomes in this phase.

However, the basis of innovation is in the knowledge and continuous organizational learning, which requires companies to develop skills aimed at creating new knowledge - involving its creation, diffusion and incorporation in products, services and systems (Nonaka and Takeuchi, 1995). According to these authors, for the **organizational knowledge creation** to occur, conditions that enable companies and allow conversions between tacit and explicit knowledge are necessary. Thus, the knowledge creation process presented in the framework has made reference to the four modes of knowledge conversion proposed by Nonaka and Takeuchi (1995), presented in the section 2.3.

Nonaka and Toyama (2003) consider that organizational knowledge creation is a never-ending process and it is continuously upgraded by itself. Moreover, the internal and external characters that encompass the knowledge creation process provide resources for continuous innovation, which allows the company to have competitive advantage (Von et al., 2000).

As mentioned before, several studies have argued that firms have different innovation capacities; this is because the ability to absorb and use external knowledge is different. (Cohen and Levinthal, 1990; Nieto and Quevedo, 2005). In this context and as a **point of view**, the **perspective of absorptive capacity** was used in the framework to understand the interaction that occurs between the fuzzy front-end activities and the process of knowledge creation, taking into account all the inputs, considered as influencing factors in the innovation process.

For this perspective, the absorptive capacity model of Todorova and Durisin (2007) was used as reference, presenting the four main activities of the external knowledge absorption process. The acquisition is the firm's ability to value, identify and acquire critical external knowledge for the company's operations. The elements that make up this dimension are related to the level that the company uses external information, such as partnership with other organizations, relationship networks, seminars, workshop, internet, database, professional magazines, academic publications, laws, regulations etc. The assimilation refers to the firm's ability to analyze, interpret and understand the knowledge obtained from external sources. Thus, the understanding promotes the assimilation, which allows the firm to internalize the knowledge generated externally. The elements that make up this dimension are related to the information and ideas communication flow between departments, especially the exchange of news, issues, developments and achievements. The transformation is the firm's ability to combine existing and assimilated knowledge in order to reach a new scheme. The elements that make up this dimension are related to the capacity of structuring and using this new knowledge to propose new insights and uses for it. The exploitation refers to the organizational capacity that enables the firm to refine, expand and leverage existing skills, allowing the creation of new ones, through the internalization and transformation of the acquired knowledge. A **collaborative** environment can enhance both Knowledge Creation and Front-End of Innovation process. It is also necessary to create bridges between inputs for innovation and the process as a whole.

5.3 Understanding the framework: the outputs

As expected result of the interaction between the processes presented in the framework, three main elements were listed. When the FFE phase ends with a **product concept**, that is, with the transformation of an idea into an opportunity, this concept will continue to evolve throughout the innovation process. However, several ideas that started the process as inputs will not become an opportunity or will be rejected. Thinking about this, Cooper et al. (2002) mentioned that a **bank of ideas** is very important for organizations to store them, leaving the ideas susceptible for future improvements suggestions. This eliminates the risk of losing good ideas that are not at the right moment or need more resources and time to be developed. Considering this, most of the time the FFE phase will end with both product concept and a bank of ideas, probably to be evaluated and improved in the future, or serve as a learning source for employees, that can check whenever they want.

These outputs of the process encourage knowledge accumulation and enhance the ability to learn, intensifying **organizational learning** and the creation of a knowledge environment

within the organization. Moreover, the learning process can be seen as part of the conditions that favor the creation of such knowledge, as long as it results, continuously, in innovative learning.

Organizational learning also can be promoted by incentive, training, conversations, meetings to discuss ideas, brainstorming etc., where employees can share their knowledge, allowing new inputs like new knowledge and skills. The company that provides space for knowledge sharing also creates learning space and becomes a good environment for development and innovation.

The influence of all the previously mentioned factors in the innovation process, as well as the way companies recognize, acquire, assimilate, transform and exploit the knowledge, can lead to different results of **innovative performance**.

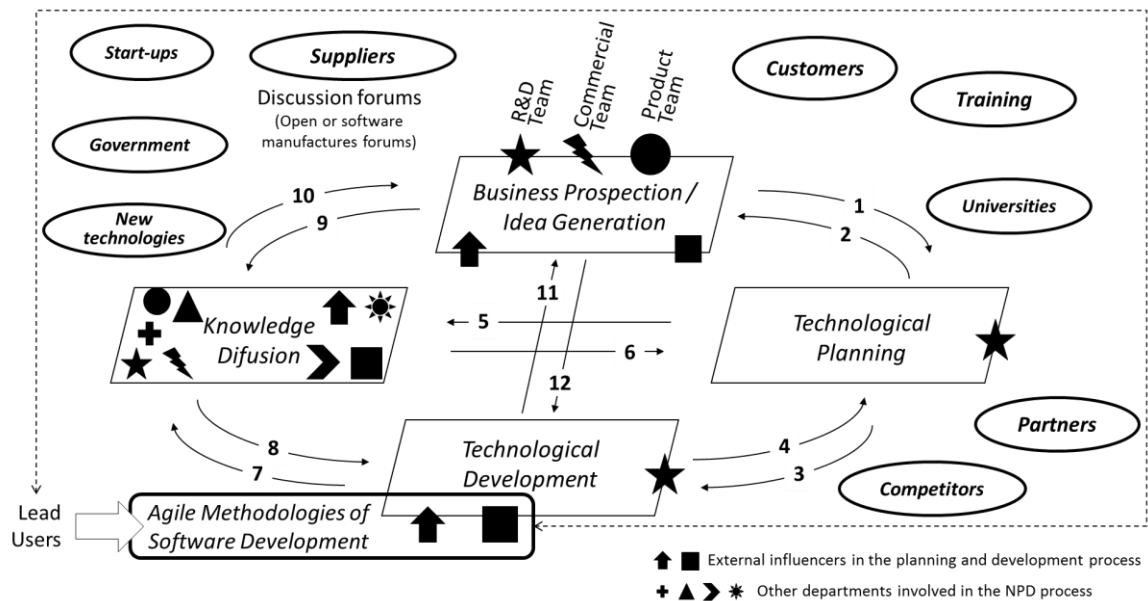
6 Case study

This chapter presents the relevant information on the case study, in order to give an overview about the context of the unit of analysis to be studied, describing the perspectives analyzed with the interviews; presents the main data collected and the results of analysis, and the confirming of the framework verification from the empirical data.

6.1 Unit of analysis context

As mentioned before, the chosen unit of analysis is a Brazilian technology-based firm that develops mobile solutions. The company has just over 100 employees and annual revenues between R\$30 and R\$50 million. For over 16 years in the market, facing the challenges of innovation, new technologies and development of new products, since 2012 the company has been seeking to adopt agile methodologies, through scrum process, in order to improve and accelerate the development of new projects. During the case study, three fundamental dimensions in innovation management were analyzed: processes, organizational context (innovation culture, relationship with the external environment, management practices, leadership styles and strategic direction for innovation) and resources.

The company is organized as comprising the following departments: Research and Development (R&D), Products and Innovation (P&I), Commercial, Quality Assurance (QA), Human Resources (HR), Operations, Support and Planning and Controlling. All these departments are involved, directly or indirectly, in the innovation and new product development process. However, the process of planning, generating and prospecting ideas, including the fuzzy front-end activities, is focused on artifacts and knowledge exchanged between the R&D, P&I and Commercial areas. Once an idea is generated or an opportunity is identified, the P&I department will be responsible for product planning, along with the commercial area, which will be in direct contact with the customer and the R&D area, responsible for the technical planning and, consequently, for the development. Considering that the company adopted an Agile Software Development method to deliver new products, the process often returns to the planning phase, that is a peculiarity of the iterative process fostered by agile methodologies. Throughout the process the knowledge is diffused among all the areas involved in a new project, through the exchange of artifacts (tangible or not). At the same time that this process occurs, the company's NPD is also influenced by actors, inputs and other external knowledge sources such as customers, competitors, suppliers, government regulations and agencies, universities, startups, discussion forums, training, new technologies and, particularly, the lead users - key players in the process. Figure 7 shows the unit of analysis' context.



Source: Prepared by the author considering the unit of analysis' context.

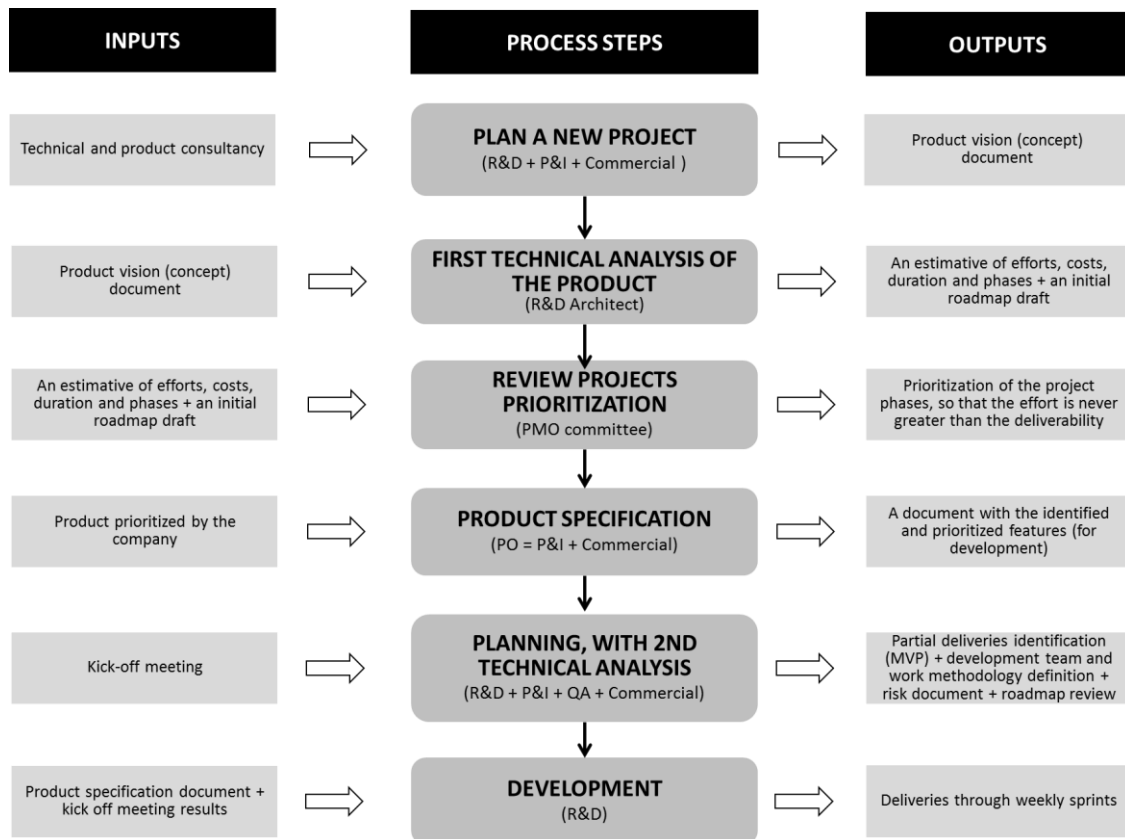
Figure 7 The unit of analysis's context

For the case study, seven employees of the main areas of the company were interviewed. The selection of employees was based on their leadership roles in their departments, choosing only the most involved in the innovation and new product development process. In addition, together they have an average of seven years of work in the company and also a high expertise in their domain areas. Considering this, data was gathered from one R&D manager, one P&I manager, two Commercial managers, one Operations manager, one Human Resources manager and the CTO (also P&I Director), considered the leader of the innovation process in the company. Two customers who have recently developed new projects with the company were also interviewed as well for the case study, in order to check the differences in the processes and methodologies adopted in product development with each customer.

In terms of case study analysis, it is important to say that the company presented two distinct types of customers, which influenced the result analysis. The first one and the main customer, addressed in this research as customers of the "type 1", are customers of a particular segment that, in the company view, hampers innovation and leave them less tolerant to error. *"Any talk that we have with this customer about being agile, to launch a MVP to test any product in the market, build a product with the end users or try to understand what they think about it before launching, is usually not very well accepted, since this customer highly values the brand and is not willing to smear it."*, says the CTO. The other type of customer are companies from different corporate segments, addressed in this research as customers of the "type 2", where the company is developing new projects together, especially public research and innovation systems. As currently there is still a heavy dependence on customer of the "type 1", as strategy the company has been seeking to launch its own products, allowing the trial and error with new processes and methodologies tests, so important in organizational learning.

Considering this, and in terms of processes, there are two important milestones in the company: in 2012 when it began to adopt the Scrum methodology - adapting it to their culture

and current customers - and in 2014, with the inclusion of new methods and tools for the front-end of innovation, like product discovery, customer developer, lean startup and others. The process adopted in 2012 can be viewed in detail in Figure 8. It was documented and shared with all employees and, since the date of the survey, has been adopted in parallel to new tools. It is for this reason that respondents have a sense of impartiality in the process formalization.



Source: Adapted by the author from the documentation produced by the company

Figure 8 The Company's NPD process in detail, created in 2012

Nowadays the company is working to build a new NPD process, enhancing the front-end activities, in order to quickly meet the market demands through existing methodologies and references in the market. Since the end of 2014 some methods and tools have been tested in internal projects of the company, as lean start-up, lean canvas, product discovery, customer developer, rapid prototyping, validation with lead users etc, whose methodologies and techniques have been discussed previously. Within this new structure, the company created 3 different business verticals formed by multidisciplinary teams.

One of the great advantages raised in the literature for use of agile methodologies is the continuous interaction with the user until it is possible to understand their needs and what must be delivered at the end of product development. Maybe it can justify the company's difficulty to formalize their current process, since these new methods and tools adopted by the company can be used only with customers of "type 2". As mentioned by the operation manager, *"we are still very tied to the interests of customer 'type 1' and this puts us in a box because it prevents us from innovating."*

Another important point is that product innovation can be seen as a result of technological development that takes advantage of a marketing opportunity. In this sense, it is impossible to ignore the importance of the organization to be effectively connected to the external environment to be innovative. That's mainly due to the need to acquire technological knowledge and to map and assess trends and market opportunities. Thus, this research also sought to understand the opportunities that the company has to learn with the environment, through its relationship with external actors.

Finally, but not least, the implementation of innovation processes amid the established context, emerges from the use of organizational resources, of all kinds, whether financial, infrastructure or intangibles. Considering this, the research also sought to raise data about these resources, which are detailed in the analysis perspectives.

6.2 Perspectives of analysis & Data Collection

This paragraph aims to highlight some important data collected to verify the framework. To achieve this goal, Table 2 will present the perspectives of analysis (column 1), whose data were collected through the questions used for the interviews (Annex A). The result of each perspective is presented in column 2, supported by quotations from the interviewees to justify the analysis. Finally, column 3 indicates which framework element was verified for each perspective and result. The data collected from the perspectives will be analysed considering three key components underlying this research: fuzzy front-end, absorptive capacity and knowledge management.

Table 2: Perspectives of analysis, results and verified framework elements

FRONT-END OF INNOVATION PERSPECTIVE		
PERSPECTIVES ON THE UNIT OF ANALYSIS	RESULT OF THE ANALYSIS	VERIFIED FRAMEWORK ELEMENT
<p>Innovations in the firm Innovation is something new that aggregates social value and wealthy (Tidd et al., 2008) Products are rarely new to the world, only 6% to 10% of the projects are really new innovations to the world, that is, something that is new only within the organization is also an innovation (Tidd et al., 2008)</p>	<p>- Innovation on products (new products and also incremental innovations in the existent products) <i>"We always make incremental innovations in the existing products."</i> (Commercial manager)</p> <p>- Innovation on processes <i>"We always try to change our processes, for example the way we make our performance evaluation. I think this way is an innovation in the company, because the process is exclusive for us, it is aligned to our values and culture."</i> (HR manager) <i>"We migrated our infrastructure to the cloud. This is an innovation!"</i> (Operation manager) <i>"When I entered in the department we did not have an official demands or problems management tool. We searched out the possible tools for this type of need. We selected one with an open code and started using it. It was a great benefit [. ..] and I think it is a good innovation in my department."</i> (Operation manager)</p> <p>- Innovation on business model <i>"Brazil does not value the software patent, it is possible only register a business model or application. Thus, the company has registered two patents in the past following this idea, but that did not bring visible benefits. Now, we are currently trying to register a new patent in a product that we are working, because it is not a technical innovation, but an innovation in the business model. We will do this not as a differentiation strategy, but as market and marketing strategy."</i> (CTO)</p> <p>- Other types of innovation were not found</p> <p>- The company is also open to spinoffs and has already achieved a first initiative from the identification of a marketing need <i>"Our big challenge now is to create a model where we can make a spinoff from the employees' ideas and we can give participation to them in accordance with the result"</i> (CTO)</p>	<p>The outputs</p> <ul style="list-style-type: none"> • Innovative performance
<p>Organization of the innovation process in the company Search, select, implement (acquire, execute, go-to-market, sustain) are part of the basic pattern of the innovation phases. (Tidd et al., 2008, pag. 90)</p>	<p>- There isn't a continuous innovation process in the company, but some isolated actions happened in the last two years. One of the processes below were applied in these actions:</p> <ul style="list-style-type: none"> - Opportunity > Viability > Execution - Problem > Learning > Implementation - Ideas > Selection > Development <p><i>"From a problem, we try to find out which product meets the user needs, along with their feedback."</i> (P&I manager) <i>"The challenge is to understand a solution, enable it with the smallest effort, to test and gain scale with this product."</i> (Commercial manager) <i>"First we have a product vision document; then an effort measurement, usually made by the technical team, to understand costs and deadlines; after that the project goes</i></p>	<p>The process</p> <ul style="list-style-type: none"> • Fuzzy front-end activities • Work methodology • Collaborative innovation • Feedback that enables the constriction of knowledge

	<p>to a prioritization list and, if approved, it goes to execution." (R&D Manager)</p> <p>"We had some isolated programs, but we did not have a recurring process of innovation." (P&I manager)</p> <p>"Since 2012 some specific and isolated initiatives have been adopted within the company, from the use of the traditional innovation funnel (ideas generation, evaluation, selection, implementation or not, value generated if implemented), until the assembly of multidisciplinary teams to plan new products from a specific market demand, using customer developer method and presentations for people in the company through an Elevator Pitch¹⁶, as if it was in a start-up." (CTO)</p> <p>- All these innovation initiatives had an approximate participation of 30 to 35% of the company human resources</p> <p>"I believe many people do not participate of the innovation initiatives due lack of time or interest. [...] We also applied an internal questionnaire and 15% of participants answered that the company did not need to innovate" (P&I manager)</p>	
<p>Order and division of the front-end of innovation process in the company</p> <p>It is essential to structure routines in the company with periodicity and systematization. This avoids a spontaneous and inarticulate innovation process. (Tidd et al., 2008)</p>	<p>- Unarticulated process of innovation.</p> <p>"Nowadays we do not have a formal innovation management process. We are currently trying different things." (CTO)</p> <p>- The company has an innovation committee to discuss processes, but there are no routines established and, as some employees left the company, there was no meeting this year until the date of this research</p> <p>"We have an innovation committee where we are increasingly seek to generate ideas within the company and also make co-creation." (P&I manager)</p> <p>"The meetings happen every two weeks, but this year we did not have many of them" (H&R manager)</p> <p>"This committee tries to discuss the processes used in innovation initiatives; however, after "Employee" left the company we did not have more meetings." (Operation manager)</p> <p>- Before the development, the front-end of innovation is divided, most of the time, in (Figure 8):</p> <ol style="list-style-type: none"> 1) Preparation of a product vision document (What is the product, its objectives and draft of roadmap for the future) 2) 1st technical analysis of the document to estimate effort, cost, time and phases of the project 3) Preparation of the product specification 4) Planning with 2nd technical analysis: possible partial deliveries, team formation, risks document and roadmap review <p>"All company projects follow this process. However, the</p>	<p>The process</p> <ul style="list-style-type: none"> • Fuzzy front-end activities • Collaborative innovation

¹⁶ "An elevator pitch, elevator speech, or elevator statement is a short summary used to quickly and simply define a profess, product, service, organization, or event and its value proposition. The name 'elevator pitch' reflects the idea that it should be possible to deliver the summary in the time span of an elevator ride, or approximately thirty seconds to two minutes." (Wikipedia Definition) Available on https://en.wikipedia.org/wiki/Elevator_pitch. Access on 12 July2015.

	<p><i>company has greatly changed its structure over the last four months. We are setting up small companies within the company or verticals focused in a specific business segment."</i> (R&D manager)</p> <p><i>"Our challenge is to apply the new process in all our products: identify an opportunity, create a prototype, validate with the end user through hypotheses, CAD matrix (Certainties, Assumptions and Doubts) and A/B testing¹⁷, to come out with a product concept to develop a MVP version and quickly release in the market, always focused on solving the identified problem. [...] the 1st initiative lasted 1 week and a half, but the goal now is to reduce all the planning for 1 week and to get this agility now we know that immersion is very important."</i> (P&I manager)</p>	
<p>Degree of formality for the innovation process Greater formality in the innovation process helps to reduce the uncertainty in the FFE stage, increasing process efficiency (Kurkkio et al., 2011)</p>	<p>Partially formalized: the step by step was issued for the entire company, but most of the respondents said that it is not clear and each department use their own process. It happens specially because the company changed its strategy in the last 4 months and is trying to test other methodologies from the market, like lean start-up</p> <p><i>"Overall, I feel that each department makes an adaptation of the process that was formalized, that is, an improvement to better adapt it to the team."</i> (Commercial Manager)</p> <p><i>"The company is working to consolidate new standards and methodologies so that this process can be done more and more assertively."</i> (Commercial Manager)</p> <p><i>"The process was introduced for everyone, but it was not formalized. The key-people know."</i> (P&I manager)</p> <p><i>"There is an effort to formalize, I do not know if it is already formalized."</i> (Operation Manager)</p> <p><i>"From 1 year and a half to now, we had several meetings to try to model, not in a too rigidly way, which was expected for a new project within the company."</i> (R&D Manager)</p>	The process
<p>Conflicts in the idea generation and opportunity for improvement in the innovation process Barriers in the FFE often result in cost problems in the later stages of the NPD (Kurkkio et al. 2011).</p>	<p><i>"I realized that sometimes the company's board has an attachment to an initial idea, even though there is an invalidation of the idea through research or hypothesis tested with end user and this can lead to failure of the product."</i> (P&I manager)</p> <p>- The process is the conflict! As it is new and is being tested and further defined by the company, not everyone knows the process or how does it works</p> <p><i>"I think the first conflict is the process. As it is new and is still being created, we do not execute it in a fast way or 100% aligned."</i> (Commercial manager)</p> <p>- Lack of communication between people (the opportunity to improve would be to place multidisciplinary teams to work together)</p> <p><i>"The biggest problem is still the communication between people, things get lost. It is also important to say that</i></p>	<p>The process</p> <ul style="list-style-type: none"> • Fuzzy front-end activities • Collaborative innovation

¹⁷ "A/B testing is jargon for a randomized experiment with two variants, A and B, which are the control and treatment in the controlled experiment". (Wikipedia Definition) Available on https://en.wikipedia.org/wiki/A/B_testing. Access on 30 August 2015.

	<i>what is leading us to make this change in business is because people are isolated, there are many departments and these people only see each other in meetings. [...] The idea of multidisciplinary teams by business vertical is to bring people closer, so they can have their product as focus, and not their department."</i> (R&D manager)	
Time spent with activities related to the innovation process Mauzy and Harriman (2003) state that a short time can compromise the quality of ideas.	<ul style="list-style-type: none"> - Insufficient for most of the respondents - Some team leaders and departments spend more time with innovation, like in projects of R&D and planning or developing new products <i>"I believe it is insufficient, considering the process of change that is taking place now. We have 3 main bets and we need to focus on them rather than innovate and create new products."</i> (P&I manager) <i>"My department spends around 20% or less with innovation, once we are focused on product operation. I think it is insufficient."</i> (Commercial manager) <i>"In my department most people are not interested in innovation. I think it is a profile problem, once they are very technical persons. Another problem is that innovation is not part of the company's culture. In my opinion, If we do not have a culture, anyone will feel responsible for it."</i> (Operation manager) <i>"Nowadays I spend 80% of my time working with new things. In the case of R&D staff, they spend at least 50%."</i> (R&D manager) <i>"90% of my time is to work with innovation, mainly because I work with R&D projects. In the case of my team this number decreases to 20%."</i> (Commercial manager)	The process
Responsible for opportunities identification for innovation Everyone has ideas all the time, but not all are creative and lead to innovations. (Vandenbosh et al., 2006)	Everyone can give ideas in the company, but most of the time opportunities are identified by: <ul style="list-style-type: none"> - Board members - Business Managers - Product and Innovation department - R&D department - Customers - Partners <i>"Most of them come from Commercial, Board members, P&I and R&D."</i> (R&D manager) <i>"Ideas can come from a market demand, once we have customers who require products or solutions. They arise from opportunities identified inside the company, based on people's knowledge and also from feedback of problems."</i> (Commercial manager) <i>"Not all ideas are implemented, usually we discard those that are not part of the current company strategy."</i> (R & D manager)	The inputs <ul style="list-style-type: none"> • Individuals • Ideas • Innovation drivers • Market pull • Prior knowledge
How external ideas enter in the company's innovation process According to Koen et al. (2001), external	<ul style="list-style-type: none"> - Benchmark of competitor and new trends in the market - Meetings with Customer - Fairs - Feedback from the end users - Partnership with research institutions - Etc 	The inputs <ul style="list-style-type: none"> • Individuals • External environment • Lead users

ideas are vital to the innovation process, and these can come from distribution channels, customers, competitors etc.	<i>"This is not a consolidated process, but the idea is that they enter in the same internal process of NPD, using the Product Discovery and Customer Development. We are trying to make a more scientific management in the company, in which everything are hypotheses. So, if I say it's better to put this table in that corner because people spend more at the other corner, we want to prove what we are assuming. We are trying to treat the hypotheses with less impartiality as possible."</i> (P&I manager)	The process • Tools and methods used in the front-end activities
Relationship with external environment Vinding (2006) says that the establishment of closer external relationships can increase the potential effect of transferring information as well as tacit knowledge.	<ul style="list-style-type: none"> - R&D co-operation (universities inside and outside Brasil and governemnt) - Relationship with startups - Relationship with suppliers and competitors - Close relationship with customers - Relationship with market, in general (fairs, workshops, forums etc) - Government agencies <i>"We have close relationship with our customers; with universities, in order to close innovation partnerships in technology, we are working closely with startups in our region and San Pedro Valley and with government agencies, through our technological park."</i> (CTO) <i>"The external actors are influencers of the results and products we provide"</i> (P&I manager) <i>"We are also influenced by the market in terms of regulations and rules governing our services."</i> (Commercial manager)	The inputs • Individuals • Organizational context • Institutions • Market pull
Involved in the early stages of the innovation process The actors involved in the idea generation process should keep the organization's strategic drivers in mind. (Rainey, 2005).	<ul style="list-style-type: none"> - Basically, the managers or leaders of three departments: Commercial, Product and Innovation and R&D - The director of the business vertical is always involved in the process <i>"The main teams involved are P&I and Commercial area, along with the board members and the development team. But nowadays most of the opportunities are formed by P&I and Commercial."</i> (Commercial manager)	The inputs • Individuals
	<i>"The commercial area will suggest or bring opportunities and P&I will create the product vision document. Together we will try an agreement according to the client's opportunities and the company's strategy."</i> (Commercial manager)	The outputs • Product concept
Respondents' suggestions for the success of the FFE phase It is essential to understand the activities, problems and management challenges to improve the proficiency of the NPD and succeed in the FFE. (Kurkkio et al .2011).	<ul style="list-style-type: none"> - Formalize the new product development process with the entire company <i>"The NPD process must be explicit for the entire company. As we are adopting new methods, tools and techniques, I can not see all stages of the product strategy definition."</i> (Commercial manager) <ul style="list-style-type: none"> - Reduce for 1 week the product planning time and prototype testing with the end user, without losing quality, in order to validate and launch the product faster <i>"We spent four days for some initial planning activities of a product, being in our room and involved in other projects. Something that being immersed we would spend about 1 day and a half. Our challenge is to have a product concept, validated by the user, in one week. This agility is important for us to respond quickly to market demands - reducing customer waiting time - and not lose the release timing of a product."</i> (P&I manager)	The process

	<p>- A smarter tool to help in the product development prioritization based on the effort and to give an overview of everything that is being planned or developed</p> <p><i>"Maybe if we had a tool that brings a smarter way to visualize the project efforts control, with a timeline and to help in prioritizing, would be very good. Nowadays it is done redundantly, with several repeated inputs."</i> (R&D Manager)</p>	
KNOWLEDGE MANAGEMENT PERSPECTIVE		
PERSPECTIVES ON THE UNIT OF ANALYSIS	RESULTS OF THE ANALYSIS	VERIFIED FRAMEWORK ELEMENT
<p>How the firm manages knowledge</p> <p>Nonaka and Takeuchi (1995) says that companies seeking for continuous innovation need to manage the new knowledge and incorporate this new knowledge in new technologies and products.</p> <p>Locher (2008) points out that most of the time the knowledge is not properly managed and it is wasted, since sometimes it is easier to "reinvent the wheel" than identify, locate and reuse an existing knowledge.</p>	<p>- Partially manages knowledge</p> <p>- The company does not have a tool that manages all knowledge or documentation exchanged between the teams. All respondents cited that each area uses a tool and not everyone has access to documents of other areas. Some tools used to exchange knowledge and artifacts:</p> <ul style="list-style-type: none"> • E-Mail • Dropbox • Google Drive • One Drive • Yammer • Intranet • Team Foundation Server <p>"The company has an intranet, but it is not used. Documents are dispersed in the dropbox, google drive and others use onedrive, as if each department had its own repository. [...] Generally a department does not know what is in the repository of the other departments." (P&I manager)</p> <p>"Nowadays a tool for managing knowledge is our deficit; each department uses what it thinks best." (Operation manager)</p> <p>"I believe that each department adopts its way to store their documents". (Commercial manager)</p>	<p>The process</p> <ul style="list-style-type: none"> • Knowledge creation process • Knowledge management process
<p>Knowledge flow in the FFE</p> <p>The ideas have greater impact when they are widely shared. Feedback, amplifications and modifications increase the original value of the idea while sharing the knowledge (Bhirud et al., 2005).</p> <p>Koen (2001) points out that he support from the top management enhances the five elements of New</p>	<p>- External inputs also enter in the Knowledge creation and assimilation process</p> <p><i>"Every time we have a meeting with the client and the opportunity to talk with him, we begin to understand a little about his business and, of course, we have new ideas. This is a great opportunity to bring new knowledge to the company and develop new products."</i> (Commercial manager)</p>	<p>The inputs</p> <ul style="list-style-type: none"> • Individuals • Ideas • External environment
	<p>- Partially structured</p> <p>- The top management gave feedback for all the participants in the isolated actions of innovation, sometimes allowing them to make improvements in their initial ideas to submit it again</p> <p><i>"We gave feedback to everyone who submitted an idea, giving them the opportunity to improve and submit it again for further evaluation."</i> (CTO)</p>	<p>The process</p> <ul style="list-style-type: none"> • Feedback that enables the constriction of knowledge

<p>Concept Development (Opportunities identification, opportunities analysis, ideas generation, ideas selection and concept development)</p>	<p>- Although there is feedback from the top management to the employees,, there isn't a bank of ideias in the company. <i>"If a given idea is not implemented, today it is only in people's heads. Currently we do not have anything that can be reused or resorted in the future, the idea is not documented anywhere."</i> (CTO)</p>	<p>The outputs</p> <ul style="list-style-type: none"> • Bank of ideas (not verified)
<p>People management practices Education has long been recognized as significant in improving innovation systems. Education and training increase the stock of knowledge in the organization (Mangematin and Nesta, 1999).</p>	<p>- The company is trying to create multidisciplinary and autonomous teams, in a way that they can have leaders free to make quick decisions in accordance with the company' strategy <i>"We compare our teams with an army troop, where the leaders are responsible for the development team, in a way that they understand the team strategy and the army as a whole, and will be able to make decisions quickly and independently. The example we give is as follows: it does not matter if someone of the US elite troops finds Bin Laden in the middle of the cave and call the boss asking: May I kill or attach?"</i> (CTO)</p> <p>- Horizontal model of team management <i>"We want to work in agile model and that model has to be horizontal. If vertical, agility is lost. And it is this environment of autonomy that will allow innovation to happen."</i> (CTO)</p> <p>- Attempt to carry out the selection process in the evaluation model 360° <i>"We had a very interesting process in hiring the HR manager. It was something totally 360°, the board and the president attended the interview as well as employees who would be the manager's customers. Everybody interviewed and helped to select the new employee."</i> (CTO)</p> <p>- Assessment model based on indicators <i>"We are trying to implement an indicator-based model, to eliminate any guesswork from our part when we innovate."</i> (CTO)</p>	<p>The process</p> <ul style="list-style-type: none"> • Technology, strategy, leadership and culture
<p>Internal culture x Learning process Organizations need to provide an environment in which people feel encouraged to share their information, enriching the organizational knowledge, storing it and making it available in the knowledge base. (Ponchirolli and Fialho, 2005).</p>	<p>- The company is working to strengthen the innovation culture and the exchange of knowledge between people, through multidisciplinary teams working together, where each team has a leader with authority to make decisions <i>"The idea of multidisciplinary teams by business vertical is to bring people closer, so they can [...] share knowledge and help each other."</i> (R&D manager)</p> <p>- The company also encourages creativity and the emergence of new ideas, working in the implementation of many actions <i>"Much of the discussions of our committee is how to improve the company's innovation culture. There are initiatives to paint the wall, to have a different decoration, rest room, a place to be isolated and think about new ideas and also isolated innovation programs."</i> (P&I manager)</p>	<p>The process</p> <ul style="list-style-type: none"> • Technology, strategy, leadership and culture

Absorptive capacity is also influenced by organizational factors such as organizational structure, organizational culture and organizational communication. (Zahra and George, 2002)	<p>- Training is also very important. Every beginning of year the company understands the need of knowledges and plans a budget by department</p> <p><i>"We are trying to create an environment to provide wellbeing and enhance the ability of people to develop their work. [...] The HR has been working the autonomy and intrapreneurship, the promotion of training, rotation between teams and a best decoration and organization of the internal environment, as an important role to strengthen the innovation culture, foster creativity and the emergence of new ideas."</i>(HR manager)</p>	<p>The outputs</p> <ul style="list-style-type: none"> • Organizational learning
ABSORPTIVE CAPACITY PERSPECTIVE		
PERSPECTIVES ON THE UNIT OF ANALYSIS	RESULTS OF THE ANALYSIS	VERIFIED FRAMEWORK ELEMENT
<p>Positive attitudes toward change - Acquisition dimension</p> <p>Organizations that value positive attitudes to change tend to be more innovative, since individuals tend to be more motivated to seek new information that leads to improvements for the company (Murovec and Prodan, 2009).</p>	<p>The attitude exists. Nowadays the company has a big dependence on one type of customer (Type 1, as mentioned before), which has low flexibility to innovate. But as a strategy the company is developing its own products that will have more flexibility for innovation and tolerance to error</p> <p><i>"We are still very tied to the interests of customer 'type 1' and this puts us in a box because it prevents us from innovating."</i> (Operations manager)</p> <p><i>"Any talk that we have with this customer about being agile, to launch a MVP to test any product in the market, build a product with the end users or try to understand what they think about it before launching, is usually not very well accepted, since this customer highly values the brand and is not willing to smear it. But, in order to get around this, we are trying to create a strategy where we can have our own products, that do not depend on the customer "Type 1". In those products we are much more tolerant to error."</i> (CTO)</p>	<p>The process</p> <ul style="list-style-type: none"> • Technology, strategy, leadership and culture, that leads to organizational learning • Absorptive capacity (acquisitionn dimension)
<p>Cooperation in innovation – Acquisition dimension</p> <p>The development of an active and diverse relationship network can raise the individuals awareness about the existence and location of useful information that can be accessed and incorporated into the organization when necessary. (Cohen and Levinthal, 1990)</p>	<p>- Innovations developed with partners (specially in R&D projects)</p> <p>- Partnership with universities inside and outside of Brazil</p> <p>- Partnership with start-ups</p> <p>- Partnership with government organs focusing on innovation and technology</p> <p><i>"We have close relationship with our customers; with universities, in order to close innovation partnerships in technology, we are working closely with startups in our region and San Pedro Valley and with government agencies, through our technological park."</i> (CTO)</p> <p><i>"We have a laboratory, with capacity for 17 people, at the technological park, which is an environment created for innovative companies, through a partnership with the federal university, the City Council and the State Government. [...] Through this partnership we have a great access to entities that foment and encourage research and innovation."</i> (CTO)</p>	<p>The inputs</p> <ul style="list-style-type: none"> • Innovation drivers • External environment • Technology push <p>The process</p> <ul style="list-style-type: none"> • Absorptive capacity (acquisitionn dimension)

<p>Relevant prior knowledge and education level of the employees – Assimilation dimension</p> <p>Teams with high level of education and technical skills are better able to identify and assimilate external knowledge. (Vinding, 2006)</p>	<ul style="list-style-type: none"> - Approximately 20% of the company has only Graduation with complete higher education and 25% are in progress. - Approximately 14% of the company has completed after graduation (especialization) and 12% has it in progress - Approximately 2% of the company has a Master completed and 2% are in progress. This number tends to increase a bit little due to a partnership with a national university for funding 2/3 of the course for employees - Only 1 person has completed Ph.D. - Approximately 50% of the company's background is in the technical area - In 2014, 88,9% of employees participated in some training <p>*Data from HR department</p>	<p>The inputs</p> <ul style="list-style-type: none"> • Prior knowledge and knowledge sources <p>The process</p> <ul style="list-style-type: none"> • Absorptive capacity (assimilation dimension)
<p>Connectivity (trust, cooperation and interaction) – Transformation Dimension</p> <p>Such connections between the individuals of an organization improve the efficiency of information flows between different areas, thereby facilitating the exchange of ideas and interpretations, leading then to the adaptation and use of new external knowledge in the organizational context. (Jansen et al., 2005).</p>	<ul style="list-style-type: none"> - Personal Training: The company invests in internal or external training or in internal human resources to share their own shares knowledge in a particular area with others <i>"If we identify that an area needs an specific knowledge, we always evaluate if it exists inside the company or if we need to seek outside."</i> (HR manager) - Socialization tactics: The new company's strategy of dividing departamentos into multidisciplinary teams collaborate to exchange knowledge between people from different areas <i>"We divided the comapny into three different business vertical, formed by multidisciplinary teams. Each vertical has: one Product Owner, responsible for the vertical strategy and activities prioritization; one scrum master, one commercial analyst, one director of the vertical and a dedicated development team. In addition, each vertical have shared human resources, as a designer, UX specialist, business manager, BI, service desk and operations staff."</i> (P&I manager) - Internal sources of information for Innovation: the company has internal communications channels that disseminate informations about the market, new technologies, competitors, internal decisions etc. <i>"The company has several internal communication channels for different needs: formalize the company news, introduce new technologies, introduce new employees, communicate external and internal events, give behavioral tips, trivia, jokes, communicate emergencies, training, salary etc."</i> (HR manager) - Communication networks: continuous exchange of knowledge with universities, government agencies, startups, market etc. <i>"Another initiative we have is a recurrent event to think out of the box, where we discuss not only technical issues and new technologies, but also matters that have nothing to do with our work, for example "beer", to encourage creativity. The event takes place for more than two years, is open to the external public and we also bring people from outside the company to share knowledge."</i> (CTO) - Interfaces between functions and departamentos: through 	<p>The process</p> <ul style="list-style-type: none"> • Technology, strategy, leadership and culture • Collaborative innovation • Knowledge creation process • Absorptive capacity (transformation dimension)

	<p>the teams rotation</p> <p><i>"Since the end of 2013 we implemented the team rotation. If a person is working with someone from another team, the idea is to put them physically close. This will facilitate communication and discussion."</i> (HR manager)</p>	
<p>R&D expenditures - Exploitation dimension</p> <p>Cohen and Levinthal (1990) consider that to understand the R&D results developed externally is necessary to develop internal R&D activities, considering that the development of employee learning skills would be a by-product of the activities conducted by the firm.</p> <p>The authors also showed that organizational investment in R&D contributes directly to organizational absorptive capacity. Since then, R&D has been recognized as a potential determinant in most of the absorptive capacity studies.</p>	<p>"Nowadays, around 5-10% of revenues are invested in R&D. This happens also because the company has funding lines that should be directed to research. We currently have two research projects being executed, where approximately ¼ of our payrolls is being paid by these resources we got by financing." (CTO)</p>	<p>The process</p> <ul style="list-style-type: none"> • Absorptive capacity (exploitation dimension)
	<p>- The company presented success cases when talking with the customer Type 2, receiving great feedbacks. It is a R&D project and the success can be perceived in the product results to the customer as a whole.</p> <p><i>"Everything indicates that it was the best result so far, we did not have loss and the customer is really pleased"</i> (Commercial manager)</p> <p><i>"Much of this success is linked to the project manager, who had the ability to validate what was important or not"</i> (Customer type 2)</p>	<p>The outputs</p> <ul style="list-style-type: none"> • Innovative performance

Source: Prepared by the author to conduct the interview's questions

6.3 Data analysis

Analysing the collected data, all inputs elements mentioned in the framework have been successfully verified. Once realized that the planning process begins by identifying a market opportunity or suggesting an idea that can come from inside or outside the organization, these are influenced by a number of environmental factors that comprise the macro and socio-economic context where the company is.

The organization strategy should always be established through a detailed evaluation of this external environment, without also disregard the internal environment. It should be a favorable combination of external and internal circumstances, in a way that its application is not compromised. Therefore, it is very important that the environments are well understood, since they will serve as knowledge sources for innovation.

Within this external context, the existence of specific regulations for the market in which the company operates can also be mentioned, as well as a continuing need to innovate and launch products in an agile manner, considering that the constant technological changes and the market needs are increasingly demanding.

To be able to recognize the changes taking place in this environment and well absorb the opportunities that flow from it, it is important to have a knowledge base on the part of the company's individuals, facilitating the acquisition, assimilation and use of this information in the processes that will follow the inputs. Corroborating with this view, Zahra and George (2002) define that absorptive capacity is dynamic and evolves over the time, forming and depending on the company's prior knowledge. This can be explained by the process of absorbing knowledge that tends to develop cumulatively. According to Cohen and Levinthal (1990), the more the company knows its production processes, its technology and its products, the more likely it is to introduce new knowledge in a satisfactory way. Therefore, it is possible to infer that the higher the prior knowledge, the greater must be the company's absorptive capacity and consequently the innovative performance. Invest in highly trained professionals, in-house training, external training and formalization of processes and products, proved to be a good path. Based on this, the human resources qualification can also be understood as an important input of the NPD process or a major determinant of absorption capacity, since it is considered a component of organizational knowledge.

Regarding the processes presented, the literature review on the ACAP topic shows that at least a fraction of new knowledge must be related to prior knowledge so that processes can occur at satisfactory levels. In a complementary manner to this procedural learning system, application and advantage of the knowledge, the ACAP depends not only on external knowledge, but also on knowledge transfer between the internal parts of the company. In this sense, the attempt to split the departments in multidisciplinary teams, focused on a specific area of the company's business, has shown to bring good results as the outputs resulting from this action.

The analysis of the collected data has also identified that there is a direct relationship between organization and individuals, understood as reciprocal, which depends on factors such as environment (internal and external), structure (relationship patterns) and processes (behavior established by the environment). Through the mentioned relationship and the influence of these factors, organizations can emerge in their social environments, realizing its goals and bringing benefits to all. In this way, it is very important to have an adequate sum of individual capacities and to promote an interface between the organization and key employees (key-people).

Another important aspect related to the processes and therefore liable to influence the learning and the organizational innovative capacity are methodologies that the company adopts. The use of scrum method within the company makes daily routines more agile. With the active participation of the end user in the planning and implementation of the system, it is essential to understand what they want and expect from a product for the successful development and also to deliver what they need. The collaboration between team members is also constant in this method, since the work is done with organized teams that need to communicate all the time. This agility also makes even faster the interaction with the actors of the process, whether internal or external (not less important). Instead, the agile approach is a rapid response to the changing needs and rapid development that companies have. As mentioned before, it proves to be a trend, considering the rapid pace of change and innovation in the information and communications technology in organizations and in the business environment. But for this, and not to harm the quality of deliveries, the focus and immersion mentioned by respondents were considered very important for success. The benefits that the methodology brings can be highlighted in the time that respondents say "win" with the agility of deliveries, according to the perspective "Respondents' suggestions" in the Table 2.

The feedback embeded in the model of Nonaka e Takeuchi (1995) was considered very important, since it enables the rapid construction of new knowledge, not only between the top management of the company and individuals, but also as a characteristic of the methodology adopted in the NPD process, that is essential for organizational learning. In the scrum, customers and users participate actively in the process of building products, services and results, providing feedback constantly. As well as in relationships with internal employees, this new relation should be of cooperation, in order to produce the desired results. Avoid conflicts and seek for solutions together are relevant points of this relationship. In this sense, there is a proximity with the model proposed by Whitney (2007), focused on technology, where analysis and control are essential during the process, through feedback.

The use of methodologies can also influence the organizational learning, and there may be limitations in its effect, but for that it has to take into account the organizational context, culture and people management within the company. Considering this, the company has been working to improve its innovation culture, focusing on trial and error and new ways of working in order to increase their innovative capacity and competitive advantage. For the purposes of research analysis, the contribution of the use of methods, techniques, tools etc. for organizational learning, were seen in this study as dependent on the application and of the dynamic of these methods. In addition, the success factor linked to the use of these methodologies is intrinsically connected to the management and the way the teams will adopt such methodologies in the company. Thus, the success within a company by the use of specific methods cannot be inferred in others, even those of similar organizational context.

As highlighted before, a customer of each type mentioned here was interviewed for this research and one respective project developed with the company was analized to verify the capacity to absorb the knowledge exchanged during the planning stages, as well as differences in the elements of the framework when compared the results of the two types of customers. The project developed with the customer "type 1" emerged from an opportunity identified by the costumer in the market, the trend and the interest of the end user in the subject. However, there is no user participation in the planning of it. The customer actively participated in the exchange of ideas within the unit of analysis, that created a document with the concept and features of the product to be validated by the customer. The project was developed by the team using the scrum methodology only for development. The customer mentioned that the

end user is rarely involved in the planning of new products by fear of stain the image of the brand and, therefore, the products are tested on the market only after released. Even so, the customer does not rule out that continuous improvements need to be made. *"It's always difficult to retain the user and we always have something to discover in relation to various matters. The idea is always to evolve the product, never leave it stop thinking that it is meeting user expectations and always present novelties to retain them as our clients"*, says the customer. Some market research initiatives are conducted via SMS and sent to the end user after the cancellation of the product or service. The idea is to understand the reason for stopping using it.

For the project with the customer "type 1" the company did not adopt the MVP method, since the product already existed in the market and the project proposal consisted only in the launching of a new interface, a mobile app. The company spent 6 months from the beginning of planning until the launch, considering pauses between one stage and another that together revolve around two months. This happened because the project team was not dedicated from the beginning, with the need to get involved in other priority projects of the company. Even the customer has mentioned that the company met expectations in deliveries and absorbing the demand, and that the product has been a success of use, **it became clear the importance of lead users since the beginning of product planning as an essential input of the process:** *"I'll give you an example, the client XYZ, of the 'type 1', launched a product called XPTO. Nobody asked for the market or the end user about what they needed or wanted. The feedback we got from XYZ is that the product did not succeed because people do not know what XPTO is. Look the executives making products for the mass!"*, says the Commercial manager, responsible for XYZ account. Regarding the success of the project analyzed, the customer attributed it to an end user need, identified through existing online research in the market about the interest of some classes of users for the product subject.

On the other hand, considering the models that deal with ACAP, it is possible to identify that the organizational competitive advantage stems from investments in R&D and enable capacity to generate knowledge at the individual and organizational level, from data that generate information and knowledge (Nonaka & Takeuchi, 1997). Thus, the interviewed customer of "type 2" developed an R&D project in partnership with the company analyzed and a government agency. The methodology adopted was also the scrum, but with application in its entirety, developing prototypes and assumptions, which have been tested and verified with end users of the product. Even being an existing product on the market (MVP version), this project also had the need to launch a new interface, also a mobile app. It was released in its simple version on the market (4 features), with more 16 features planned for release over the other project deliverables. *"With dedicated team, in four months of work we already had a product validated by the customer and end user, ready to launch with its basic functionality"*, says the Commercial manager responsible for the project. As a result, scientific research was also delivered during the planning, generating new knowledge for both the company and the customer. *"Everything indicates that it was the best result so far, we did not have loss and the customer is really pleased"*, he adds. This success and satisfaction were confirmed in an interview with the customer, who recognized the organization as *"a company that can do what plans."* Among the project's success factors mentioned by the customer, some can be highlighted: *"synergy between the areas and people involved; today is the product with the most features among the companies in this sector and the current time, since the user needs technology and the segment in which the company operates lacks technological innovations, bringing an opportunity to innovate. So, I think we were very happy with this timing!"*, says

the customer. When questioned about the product success to the end user, the numbers show that in a short time in the market the product already had good market acceptance. *"Much of this success is linked to the project manager, who had the ability to validate what was important or not"*, the customer adds. This statement leaves clear the importance of highly skilled leaders who well understand the company's strategy and are able to absorb what comes out, no matter if it is an opportunity, feedback or other similar knowledge.

In relation to the outputs, only one element was not identified in the company: the bank of ideas. As stressed by Cooper et al. (2002), potential ideas may be lost by lack of a bank of ideas in the company, since it increases the risk that good ideas are not implemented in the future to have been ruled out at a time when they were not timely. On this way, the unit of analysis could improve its innovative performance by implementing a bank of ideas, considering the rapid market changes.

Overall, the organizational learning can be important for many functions inside the company, but it is essential for the new products development. This learning process can provide good knowledge and know-how about the market, new technologies, products, processes, critical success factors for the NPD and other inputs as a whole. Transforming the NPD in a continuous learning process increases the company's ability to succeed in dynamic and highly competitive environments and increase their innovative performance

Lastly, and so important, is the relevance given by respondents when asked about how they evaluate the importance of the initial phase of the NPD and the activities performed in the fuzzy front-end for successful innovation. Some answers are highlighted below:

"I think it is very important. As my department monitors the products' results, we often get the feedback that we do lot of products based on opportunities that executives map, and not on what the end users want. [...] And when we talk about the challenge of IT companies to generate new solutions every day, it is that I realize the importance of this phase and that a product makes sense in the market, so it increases the chances of acceptance and success." (Commercial Manager)

"We are trying to be increasingly assertive in the development process. If we can discover something in the beginning of the process and test it more and more before developing, we can be more assertive and save money. We will not take the trouble to develop, which is the most expensive. What we are trying to do is guess right more by spending less." (P&I manager)

"It is essential! I have to know what I'm doing. If I decide something wrong at the beginning, at the end when the product is ready and I see that this went wrong, it will cost more for me than if I had seen the problem before. So, planning is essential to avoid this problem and try to understand whether the product has or not adoption on the market." (R&D manager)

"I do not like spending much time in this initial phase, but I like a lot planning because it helps me to direct the project to have more assertiveness and even know if that product can succeed or not, or sometimes even abort the project." (Commercial manager)

7 Conclusions

The need to innovate puts organizations in the midst of a challenge, as it depends on an intricate set of complex interactions between human, organizational, technological and marketing elements.

This multidimensional characteristic, coupled with the intrinsic risk presence and the need of tangible and intangible assets exploitation, makes innovation management even more challenging. It is necessary the availability of valuable and rare resources, whether tangible or intangible. However, this does not guarantee the innovative performance, that most important ingredient that must be transformed into value.

Facing this challenge under the procedural point of view is an important step. The innovation management processes are guides that govern the flow of opportunities transformation into innovative products for the good use of resources, whether financial, human, structural or intangible. The constant presence of uncertainty among the innovative activities makes the processes become key pieces, avoiding innovation to be seen as something that occurs "by chance". This procedural structure is translated into routines that enable the existence of an innovation value chain in the organization, with clear inputs and outputs on its individual steps and a fluid flow in the process as a whole.

However, the development of innovation management processes is also insufficient for it to occur. As shown in the theoretical foundations presented, the implementation of systems that enable the promotion of innovation in a systematic way requires a proper organizational context to conduct the innovation efforts. This context is translated by the dynamic with which people and departments interact between and among each other, by the configuration of power positions and decision-making locus, by the quality and scope of the organization's relationships with the external environment and the socio-cultural conditions that shape individual and collective attitudes for the innovative activity.

It is clear that the competitive and technological environment of the sector, the size of the organization and the national innovation system where an organization is involved are factors that influence the characterization of the barriers to innovate and develop new products. However, we can't ignore the internal dimension of the organization that is linked to the way a company structures and executes its innovation management system, to understand its specific difficulties. In this sense, the difficulties to innovate were seen here as management challenges - obviously without neglecting the influence of external variables in this process.

As already mentioned, the challenge of innovation management is complex. This complexity stems from the fundamental characteristics of the process: it involves a high level of risk and uncertainty, requires the involvement and mobilization of various areas of the organization and also expertise from different actors, presents a range of internal processes that have non-standard subproducts, requires a constant and intelligent environment monitoring, involves the allocation and management of resources with a high degree of specialization, requires structural agility for continuous internal reconfiguration inside the organization and requires understanding the nature of their main resource: the knowledge (Tidd et al., 2008; Nonaka and Takeuchi, 1997).

In this context, and seeking for a progress related to the innovation theme in the literature and in the scientific world, this work brings important contributions in two dimensions.

- **Scientific world:** It establishes a systemic theoretical framework potentially useful for future research, in which conceptual elements from different fields of research are systematized and integrated. In addition, and in a novel way in the literature, the work explores the conceptual relationship between different dimensions of innovation management, including knowledge management and absorptive capacity as important topics and influencers of the innovative performance of an organization. This perspective contributes to the understanding of the interdependence between the various parts of the complex innovation system - and among the innovation challenges faced by organizations, their typical symptoms and the size and practices related to them. Moreover, this also contributes to the understanding of causal relationships and provides the basis to construct new routes to improve the innovative performance and development of future front-end of innovation models.
- **Corporate world:** as mentioned before, once the theme FFE brings uncertainties also in organizations, this study aims to increase the understanding of the FFE mechanism by companies, especially for those who want to improve their innovation process and knowledge flow at this phase. In addition, the research brings a contribution to the decision making process in the innovation planning in technology-based firms. The goal is not to direct the decision, but clarify several factors, through different perspectives, that may affect it. Through these points, the study helps organizations to enhance innovation process and knowledge flow, allowing them to adapt their strategies and routines to remain competitive, in order to boost profits and differentiate themselves in a highly competitive market.

Managerial Implications

Through the analysis and results, technology firms can substantially benefit from the optimization and active improvement of the fuzzy front-end. The Knowledge management is linked to the evolution of organizational theory and, when combined with the front-end of innovation, its practice involves analyzing many different aspects as human nature conception, economic and social environment, technologies involved, organizational models, culture, management practices and more. It is understood, therefore, that knowledge management is not restricted to the statement of policies, guidelines and the management practices adoption. It's more than that and involves comprehension, attitude, understanding of the human processes of learning, of freedom, of creation and individual and collective learning. Knowledge management is a continuous and engaging process that transcends the individual behavior and seeks for the transformation of the organization in a favorable environment for new ideas and learning linked to the company's strategic and systemic goals.

On this way, the framework verification shows us that knowledge management builds learning organizations, stimulates cultural change and ensures that innovation and communication channels are being created on a daily basis, allowing the company to open ways to structure its competitive advantage. In addition, learning absorption through experience and constant exchange between internal and external individuals helps to build knowledge that can be used to improve processes and innovative capacity.

Limitations of this research

The limitations of this research stem from the fact that the framework proposed in this research was validated in the context of a technology-based firm using agile methodologies. This limitation results from the realization that not all technology-based firms use agile approaches in their processes. The fact that we have only one case study also limits the assessment of the results. However, it is the author's perception, based on her professional experience that it is very likely that the proposed framework would be as well validated in other similar organizations.

Future Research

The analysis also showed that, despite some differences, the FFE models exhibit significant convergence points. These points, in the first instance, provide a more accurate understanding of the front-end of innovation. In a second step, they can direct the organization and structuring of FFE in a specific context. Regarding the divergence points or others that still need theoretical and/or empirical insights, perspectives for future research are suggested.

Starting from the fact that most models discuss innovation in products (goods), it is considered important to further study the FFE in other development contexts, such as services, processes, business models, marketing methods and others.

New studies may also raise the techniques and tools that can assist in executing the FFE activities, as well as comparison criteria between them. Given a particular context, the criteria identification for the choice of techniques and tools appropriate for the front-end of innovation can be an important point for further research. Considering that a FFE should be appropriate to its context, it is suggested that future studies seek to deepen the relationship between the context and activities, techniques and tools for the FFE. Thus, it becomes important to investigate ways to determine the appropriate sequence of activities as well as the techniques and tools to be used based on the context of an organization.

Since the FFE is a developing theme, with few empirical approach, fieldwork that allows to see how specific organizations manage this start of the innovation process can contribute a lot to the understanding of the theme.

New studies related to the FFE are recommended not only to fill research gaps, but mostly because this new knowledge can improve the innovative performance of organizations, as well as bring significant contributions to advance the literature on the subject.

Finally, and as stated, the theoretical background developed on the key studies leads to the conclusion about the complexity involved in the transformation of the classical organizations into organizations with best innovative performance. So, the challenge with this research is to allow these companies to learn and adopt lifelong learning practices that maintain the environment conducive to creativity, innovation and spontaneous contributions. In short, allow them to be aligned with the best practices in management and innovation.

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ANNEX A: Checklist of questions for interview

To conduct the data collection for this research, different checklists of questions were created according to the respondent profile or approach. The checklist below does not reflect all the questions asked. Since it was used only as a reference, new questions emerged according to the responses. For consultation purposes, 8 of 9 interviews were recorded with prior permission of the respondents.

Checklist for most of the internal respondents, except the CTO and the HR manager. This last one answered questions from the checklist below and the checklist of the CTO:

1. General questions about the interviewee:

- 1.1. What is your position within the company? How long are you in the company?
- 1.2. What is your background?
- 1.3. Tell me about your main responsibilities and responsibilities of your department within the company

2. Questions about the NPD process within the company

- 2.1. Is there any formalization? (How it is presented, who has access, if everybody knows etc)
- 2.2. In general, how NPD process starts in the company? (idea, opportunity, who is involved, how it occurs, use of specific methodologies or techniques, the end result of this process etc)
- 2.3. What are the steps and how the activities are conducted? (Is it divided into steps or sub-steps?, If yes, what are they and activities that comprise it, as well as its order?)
- 2.4. How the activities covering more than one department or area of the company are coordinated? (Does it occurs at the same time? Does an activity depends on the other? What kind of documents are generated? How docs are shared?)
- 2.5. How do you assess the importance of this initial step for the the innovation/NPD processes outcomes?
- 2.6. What are the main problems, conflicts and/or solutions you can observe at this stage? (What is working well or could be improved?)
- 2.7. Would you change anything at this stage to be more successful after the development of the innovation?
- 2.8. How does the external ideas, such as those coming from customers, end-users feedback etc, enter in the company's innovation/NPD process?

2.9. How much time per day, on average, you or your department work in activities directly related to the innovation process? Do you believe it is enough?

2.10. The literature says that innovation is something new that adds value. Products are rarely new to the world. Only 6-10% of the projects are really innovations to the world. This means that something new just within the company is also considered innovation. Thinking about it, can you describe three innovations occurred in the company in recent years and its type? (product, process, business model etc). How does the process started?

3. Ideas X opportunity for innovation

3.1. Who has ideas for innovations and where they come from?

3.2. Does every idea generated and/or captured by the company can be developed? (What is done with the ideas that are not accepted?)

3.3. How the evaluation of ideas for development is made and what is the fate of these ideas? Is there metrics for evaluation?

3.4. Does the innovations within the company derive more from ideas or identified opportunities?

3.5. Who identifies opportunities for innovation and where they come from?

3.6. When an idea is already being developed, is it likely to be stopped or eliminated? How is this process?

3.7. How does the company equilibrates new ideas for innovation with the projects that are already being developed?

4. Knowledge management

4.1. Is there a tool to assist the process of knowledge creation and management in the company? (i.e.: benchmarks, communities of practice, corporate education, discussion forums, lessons learned, electronic document management, competitive intelligence, skills and processes mapping, best practices, corporate portal, knowledge bases etc.)

Checklist for CTO (including HR manager in some questions)

The innovation management is organized in three basic dimensions, processes, organizational context and resources:

Processes

- In terms of process, it has been well discussed with the other respondents, but I'd like to hear your opinion about the current situation of the company and changes you are expecting to do.

Organizational Context

- Well-structured processes are not enough for innovation to occur. The processes execution will always be people's responsibility and influenced by the way they relate. In this sense, tell me a little about the culture of innovation within the company. What are the people management practices? Which people's leadership style the company seeks for the team managers profile? What is the strategic direction for innovation? (Flexible? Tolerance for error, risks, uncertainties? Does the company gives autonomy? Does it stimulates creativity?)
- How is the organizational structure and governance for innovation within the company?
- And how is the relationship with the external environment?
- Does the company is opened to spinoffs?

Resources

The execution of innovation processes, considering the established context, is done by the use of organizational resources, of all kinds.

- Financial resources: could you tell me what percentage does the company invests in innovation, R&D infra structure and new technologies acquisition?
- And in terms of infrastructure resources for R&D activities? (i.e.: existence of research labs, product certification, specific softwares etc.)
- Talking about the intangible assets, they are resources effectively responsible for the organization's innovative capacity. It encompasses the whole body of tacit and explicit knowledge accumulated in the company. So, it involves the skills embedded in the individuals and groups and active knowledge encoded in its internal records, whether them appropriated or not in the form of intellectual property. What do you have to say about these intangible resources in the company?

Checklist for external respondents

1. General questions about the interviewee:

- 1.1. How long are you in the company? What is your position?
- 1.2. What is your background?
- 1.3. Which projects have you developed in partnership with the company? Did you participate actively? How did you participate in these projects?

2. About one of the projects developed with the unit of analysis...

- 2.1. Which company demanded the product, yours or the partner's company? (try to understand where the idea/opportunity comes from)
- 2.2. How was the planning of this product? Who was involved in both companies? Was there exchange of artifacts? Which artefacts and what was the formalization level of them or other documents exchanged?
- 2.3. Did you have participation in the product construction?
- 2.4. Did you request any change in the initial idea presented by the company? How it was received by the company? Was it absorbed as expected?
- 2.5. How do you evaluate the importance of customer participation in the product design?
- 2.6. On a scale of 0-10, what is your level of satisfaction with the project?

How do you classify the deliveries? Does it meets, exceeds or is below expectations?